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THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Started at a time when there were barely four or five hundred central station companies in the field—from 1881 to 1886 inclusive only 247 now existing went into operation—the National Electric Light Association to-day is even more authoritative and representative, when nearly 500 are organized in a single year. We have in the United States at the present time over 5000 central-station systems, and every one that amounts to anything and is conducted by progressive men is in the association and proud of its membership. This is certainly cause for congratulation upon the part of all interested in the prosperity of the central station industry, and if we may judge from the preparations for the Chicago meeting next week and the program, there is further cause for congratulation in the evidence given of abounding vitality and willingness to grapple with the problems which, as ever, beset this wonderful art of electric illumination. No field of mechanical industry has undergone more revolutionary changes than this typified by the National Electric Light Association, which has already held 30 conventions. But while such solidarity exists, combined with readiness to learn and change, and also with an aggressive commercialism ever seeking new fields of opportunity, the association may well expect to wield relatively greater influence and enjoy deeper esteem when its conventions number 60. Possibly the art may by that time have settled down to standards and fundamental bases of practice that still seem to be denied it after nearly 40 years of trial and experiment. That may or may not be, but the association will flourish under any such conditions so long as it enjoys the enthusiasm of men who, while they lead in the development, desire nothing better than to place themselves at the service of their fellows in the association ranks.

ECONOMIC ASPECTS OF VARIOUS ELECTRIC ILLUMINANTS.

Mr. Wohlauer's article, on page 1042 of this number, collates economic statistics for a number of electric lamps and presents the conclusions in a very comprehensive form. It is interesting to observe that no less than 20 different types of lamps, direct and alternating-current, are included in the tables and curves without including differences of type due to series or multiple operation. A few years ago illuminating engineers had only two of these types at their disposal, namely, the carbon incandescent lamp and the carbon open-arc lamp. The growth and development of new types of electric lamps have been very remarkable in recent years. In examining the curves and tables of the article, we should bear in mind that the various lamps considered are supposed to be already installed and only the expenses of operating and of renewal are considered. The cost of first installation appears to be omitted for all types, or taken as not materially affecting the question.

Fig. 1, which includes the multiple-circuit types, bears certain deductions that are of much practical interest. When a customer installs a lamp and buys power from a central station for operating it, the diagram indicates that, for dwelling-room lighting, the tungsten lamp is much cheaper than any other filament lamp. The arc lamps and mercury-vapor lamps are hardly to be considered as suitable candidates for such lighting. If, however, we consider shop, factory or exterior lighting, the arc lamps and mercury-vapor lamps become available. In such a case, according to Fig. 1, the tungsten lamp is ordinarily less expensive than the enclosed arc lamp, but is more expensive than the flaming arcs or mercury-vapor lamps. Curiously enough, the cheapest light of all is indicated as that of the quartz lamp, a type not yet introduced into industrial service in the United States. This is the type of mercury-vapor lamp that boasts of certain red rays in the spectrum, as distinguished from the ordinary glass mercury-vapor lamp whose spectrum is a bald and dreary waste at the place where the red ought to grow. According to the tables, this quartz lamp will produce 1000 spherical candles or 12,570 candle-lumens of light for 3.25 cents per hour, with power costing 10 cents per kw-hour. This is less than half the corresponding indicated cost of the vertical flaming arc light, less than one-fifth of the indicated cost of the tungsten light and less than one-twelfth the cost of light from the ordinary carbon-filament. If these figures can be substantiated in practice, we may expect to see the quartz lamps grow and multiply.

Natural Resources.

This week a convention of governors has been called in Washington by President Roosevelt to discuss the protection of the natural resources of America in water powers, minerals, forests, natural gas, oils, etc., and the invitation has been very generally accepted. We cannot imagine any subject of more vital importance to this country or its people, and it seems impossible that such a gathering of representative men of authority can take place without good resulting. With the things that cannot be renewed or replaced, we need the minimization of waste; with resources that are recreated by the seasons we need the maximum of preservation. This is in the best interests of all the people to-day and of our successors to-morrow. We shall know less of hard times when we eliminate the extravagance that makes for panic and cultivate the economy that underlies all wealth. The President has the cordial good wishes of all engineers and publicists in this effort to conserve all that makes physical America what it is.

Private and Municipal Plants.

For a number of years there has been considerable feeling of hostility between managers of central-station companies and those connected with municipally-owned plants. While the superintendents and engineers of municipal plants are looked upon by their corporation brothers as a fairly decent lot of fellows in the concrete, the municipal-ownership idea in the abstract has in the main aroused the ire of the company managers. The chief reason for this has been that absurd claims as to extreme cheapness of production have been made by the enthusiastic devotees of municipal ownership, and that these claims have, as a natural consequence, tended to throw suspicion on the fairness of the prices made by the various private companies, and to create a sentiment that the various private companies should be displaced by municipal plants. The average central-station company manager does not have any particular grudge against municipal ownership as an abstract theory, nor would he object to municipal ownership in any other city if the cost of conducting the business were truly represented by those engaged in operating municipal enterprises. Up to the present time this feeling of hostility between the municipal and private camps has prevented much intimacy or acquaintance between the members thereof, and perhaps in many cases has even helped the cause of municipal owenership by scattering abroad the general impression that if central-station companies were so hostile to municipal ownership, they must surely be making enormous profits which municipal ownership would destroy. The public have failed to recognize the fundamental difficulty, which is that cost of production in municipal plants has been so frequently misrepresented, and that in the majority of cases this misrepresentation is due far more to ignorance than to deliberate intention to deceive. The rabid municipal ownership advocates that wilfully twist what they know to be truth are a minority.

There are to be noted at present the beginnings of a movement to handle this matter in a much more rational way than in years past, although the movement is not to the liking either of the rabid municipal ownership advocate or to the central station man who is so bitterly opposed to everything connected with municipal ownership that he cannot bring himself to think calmly in regard to the matter. The movement is not a large one, it is true, but there are a few straws which seem to indicate the way the wind is blowing. We refer to the recent actions taken by the State electric light associations of Minnesota and Nebraska admitting municipal plants to membership and inviting them to send representatives to take active part in the association. In this connection it is also to be noted that the Michigan Association has always welcomed members from municipal plants. In the Minnesota and Nebraska Associations the matter has been recently discussed thoroughly, and all sides of the question brought out. There were only one or two dissenters from the proposition that the admission of municipal plants offered such possibilities for good that they would far counterbalance any slight chances for evil in such an arrangement. In the first place, the meeting together of municipal and company plant managers is certain to result in a better understanding of the correct principles of central-station operation and accounting, both on the part of the municipal and of company men. As a matter of fact, a great many of the smaller companies know but little more about true costs than do the smaller municipal plants. By meeting together in an association of this kind, uniformity of opinion on the importance of certain fundamental principles in operation and book-keeping is likely to result, and as a result of this education, much of the misrepresentation as to costs, which has very largely been the result of ignorance, will in time disappear. As one member remarked, if uniformity of accounting can be secured for both municipal and private plants, it is worth any risk. In this respect, it is not well for private companies, as a class, to claim any too great superiority over municipal plants as it is well known that the book-keeping of many of the small companies is in deplorable condition. It is to be a case of both

company and municipal men sitting down and learning together if the problem is to be worked out in any place where State commissions do not require uniform reports. The plan has the further advantage that in case legislation is needed for the help or protection of companies and municipalities engaging in the electric light and power business, the State Association can with much better grace go before the Legislature with requests if its membership is composed of both municipal and private plants, than if it is simply composed of private corporations.

Among the practical objections which have been urged against the feasibility of admitting municipal plants to State electric light associations, one is that many of the municipal plants are in very small towns and that the superintendent of the plant will frequently feel that he cannot afford to attend convention at his own expense, and the municipality would never make an appropriation to send him. Another is that in many cases there will be difficulty in getting anyone to attend from a municipal plant, the actual operation of the plant being in the charge of a man of too small caliber to make attendance at convention profitable; while the city officers in charge of the financial end of the plant will not feel sufficient indentification with the electrical business to be induced to attend. These practical obstacles will no doubt prevent many municipal plants from being represented, just as similar obstacles prevent numerous private plants from being represented at State conventions. Nevertheless, there are, as was demonstrated at the Minnesota convention in February, a number of managers of municipal plants in small towns whose presence is of value at any State convention. As to the danger which some central-station men have urged, that the admission of municipal plants to associations of this kind is likely to result in their taking entire possession of them and running the association in the interests of municipal plants, as against privately owned companies—that possibility is entirely too remote to be worth a moment's consideration. Those familiar with association work of this kind know that every State association depends for its existence upon the attendance and efforts of a comparatively limited number of the most progressive and able central-station men of the State, and that municipal plants, which practically have no permanent executive head, and which in general contribute so little to the progress of the art, should muster up a convention attendance sufficient to overpower the representation from private companies, is nothing short of ridiculous. The only difficulty will be in arousing sufficient interest among municipal plants to secure the attendance of their representatives at conventions.

OVER-SHOOTING OF TUNGSTEN INCANDESCENT LAMPS.

As our readers may remember, we published in our issue of April 25 last, on page 859, an article by Mr. John B. Taylor on the new observation of over-shooting in tungsten-filament incandescent lamps. In our editorial columns of the same number comment was made on the newly reported phenomenon, with a recommendation that the experiment should be repeated to secure photographic evidence that the effect was an objective or real physical event, and not a subjective or apparent influence upon the sensory mechanism of the observer. In this number, at page 1046, Mr. Taylor reports further observations in support of his original statement, and presents a pair of photographic records which speak for themselves. Judging from these photographic reproductions, there seems to be no room for further doubt upon the question of reality versus visual sensation. The photographs indicate a distinct increase in the radiation intensity of the lamp, when first turned on, over the normal and final radiation intensity. The effect is clearly presented in the upper photogram for the direct-current experiment. Starting at *A*, with the lamp cold, there is no record of the moment of closing the circuit. If, however, we take the tip of the arrow near *A* to correspond with the instant of full radiation intensity, then the interval of time which elapsed between the first recorded appearance of light at *A*, and the attainment of full intensity, seems to be 0.012 second; or the time spent in coming up from first recorded brightness to full brightness was about the 80th part of one second. But after the lapse of approximately one-tenth of a second, the intensity of the record is shown at *B* to have fallen off to a subsequently steady value. When the lamp is turned off at *C*, the subsidence of radiation can be detected on the picture for one-thirtieth of a second. Again, when the lamp is relighted at *D*, the growth of radiation can be traced on the picture for one-thirtieth of a second, but there is no evidence of over-shooting at *D*. The interval of time between *C* and *D*, the turning-off and turning-on again, as stated in the article, is only about two-thirds of a second.

The retarded growth in radiation intensity at *D* when the lamp is turned on for the second time may perhaps be explained by the fact that the filament had not time enough to cool off completely, so that its resistance would be much higher than when starting cold at *A*. This must be the reason for at least a part of the delayed relighting; but the over-shooting at *A B* would not be explained in such a manner. Moreover, on a direct-current circuit, any inductance present could not explain the action. Only two possible reasons suggest themselves. One is that when the filament starts cold, and admits a great initial rush of electric energy, it takes time for the resistance of the filament to increase with temperature, or that there is a lag of resistivity behind temperature that is rendered appreciable when the temperature is increasing at the rate of about 100,000 deg. C. per second. No such phenomenon has been reported hitherto, so far as we are aware. That is, there is supposed to be no appreciable time lag between the temperature of a conductor and the amount of resistivity which pertains to that temperature. When the temperature comes up, we are accustomed to think of the full corresponding development of resistivity coming up along with it. The second suggestion, offered in Mr. Taylor's articles, is to the effect that residual gases absorbed, either in the cold filament or in the walls of the lamp-chamber, may be driven out when the lamp is heated and affect the luminous intensity in some way, such as by a lowered degree of vacuum. According to the observations thus far recorded, the overshooting has been more marked with thicker tungsten filaments. The subject should certainly be investigated, and the determination of the active cause or causes of overshooting should be valuable as well as interesting information. It would, moreover, be desirable to secure, with the regular oscillograph, records of the rate at which electric energy enters these filaments when the lamps are turned on, cold and hot. The oscillographic curves of current rise in the different types of tungsten lamps, which reveal different degrees of the effect, might throw light upon the subject.

The Commonwealth Edison System.

In honor of the National Electric Light Association convention gathering at Chicago next week, we have prepared and present elsewhere in this issue a set of articles on the system and operating practice of the Commonwealth Edison Company at Chicago. While this probably constitutes one of the most comprehensive descriptions of a large central-station company's equipment and practice which has ever been presented in a single issue of a technical journal, the magnitude of the subject is such that our article can attempt to do little more than cover the most notable points. To the central-station man coming from the small town, such a system interests by virtue of size, if on no other account. Its equipment and methods of doing business are on such a large scale that he finds many things not applicable to his own problems, but also many details which he can with advantage take home and apply. To other large central-station companies, Commonwealth Edison practice has many points wherein its experience is of immediate and practical value in the larger engineering problems.

The interest of convention visitors this year will, of course, center around the great Fisk Street steam-turbine plant and its annex across the river at Quarry Street. We imagine many visitors will feel as if they had awakened from a Rip Van Winkle sleep when they note the size to which the Fisk Street station has grown in the five years since the last convention, and the tremendous strides in steam economy that have been made. Between the first and fifth turbines installed there is a reduction of consumption from nearly 24 to less than 13 lb. of steam per kw-hour; the steam economy represented by the latter figure being so high that present efforts are being devoted mainly to improving boiler efficiencies rather than to seeking improved turbine economies. In this connection the evolution going on in these stations has been in the direction of a much higher rate of working for boilers of a given rating, grate areas having been steadily increased in proportion to heating surfaces.

From a financial and business standpoint, one of the most notable things about the Commonwealth Edison system is the large amount of energy being generated for electric-railway purposes and sold to corporations which are entirely independent of the central-station company. This result practically shows that the Commonwealth Edison Company has been able to underbid railway companies at producing energy. By a wise selection of voltage and frequency it was made possible for railway companies to erect their own substations with 25-cycle rotary converters and purchase energy from the central-station company with the possibility of utilizing these same substations to receive energy from their own generating plants, should they ever desire to build such plants themselves. The price for electrical energy of ½ cent per kw-hour, plus $15 per year per kilowatt of maximum demand at the station busbars, has evidently been so near the cost of production plus interest on investment that the street- and elevated-railway companies of Chicago have not seen fit to invest in generating plants of their own where additional energy has been needed. In some cases the old plants owned by the railway companies are being used simply to reduce the peak load demanded from the Commonwealth Edison Company, and so to reduce the investment charges. For other than peak loads the low-operating charges of the Fisk Street station are taken advantage of.

While the railway business taken on in the last five years has been largely responsible for the tremendous rate of growth, the company's regular electric lamp and motor service also shows an increasing rate of growth during the past four years, which should be an encouraging sign not only to the Chicago company, but also to other central-station companies of the country. It indicates what has been apparent in a number of other cities, namely, that the central-station business is becoming a more important factor in turning the wheels of a community than formerly, and that in the future it will, with proper treatment, grow more rapidly than ever.

Methods of Grounding.

We are glad to note that at the recent Iowa Electric Light convention the discussion on the grounding of secondaries resulted in the appointment of a committee to investigate the best methods of grounding. The question of the advisability of grounding seems, as far as the National and Iowa conventions are concerned, to have got far beyond the point where anyone can be found to oppose it on the floor of a convention, and to have settled down entirely to a consideration of the best method and means. It is especially desirable that various State and local organizations of this kind should take steps to investigate the matter, for the reason that soil conditions differ greatly in various parts of the United States, and the central stations in each locality should make a topographical study for themselves. An imperfect ground is worse than none at all, because of the false security it offers. At the present time, four general methods have been pursued, each one of which has its peculiar local conditions to which it is best adapted. First, is the buried copper ground plate surrounded with charcoal or coke, as recommended by the National Electrical Code. The next is the plan of driving a ⅝-in. galvanized-iron pipe about 10 ft. into the ground. Both these methods of depending upon the ground for conductivity having failed in some localities, recourse has been had to waterpipe systems. Some companies ground each consumer's service connection to the service water pipes. There is also the possibility of grounding transformers to water mains where the mains are located close to the transformer. Another method used where ground plates have proved unreliable is to run a continuous grounded secondary over an entire system, and make secure grounds to water pipes at substations or other convenient points. The investigation of the subject of grounding by various local associations should greatly assist the framers of the National Electrical Code in making suggestions on grounding, to say nothing of the aid it would be to central-station companies, all of which are earnestly trying to render their systems more secure against accident.

A Proposed Synthetic Primary Standard of Light.

The march number of the *Proceedings* of the American Institute of Electrical Engineers contains a very suggestive paper by Dr. Steinmetz on the subject of a primary standard of light. Up to the present time, our so-called primary luminous standards have been flame-standards. That is, we supply a mixture of air and of a certain hydrocarbon to a burner in such a manner as to produce a flame of definitely reproducible physical characteristics. When we obtain the proper standard flame, we secure, with a certain degree of approximation, carbon particles at a certain temperature. The oscillations in these particles produce electromagnetic waves, in the surrounding ether, of

certain amplitudes and average wave shapes, that affect our eyes in a certain corresponding manner, and produce a certain intensity and color quality of light. This is an empirical method, and it is the best we have been able to arrive at. It is true that at one time it was proposed to use the radiation emitted in the normal direction from a square surface of freezing platinum; i. e., molten platinum at the very high temperature of solidification; but this plan was not found to work well. At the present time, Germany uses a standard amyl-acetate flame, France a colza-oil flame and England a pentane flame.

These primary standards do not admit of being accurately compared, because their colors are different. Our eyes are able to compare quantitatively luminous intensities of the same color, but no satisfactory means have yet been found for comparing luminous intensities of different colors. These different-color sensations are distinct physiological impressions, just as the taste of sugar is distinct from the taste of almonds, and we have no means of comparing accurately the intensity of sugar taste with the intensity of almond taste. Physiological responses to stimuli are, moreover, different in different individuals, or in the same individuals at different times and periods of life. We have no knowledge as to the precise relative response of the average human eye to different colors, at the present time, and at the time, say, of the zenith of the Roman empire. Nevertheless, light as a physiological stimulus is a matter of production and sale at the present day. We know very little about the matter, but enough to work with provisionally. Dr. Steinmetz proposes to build up white light by taking certain intensities of definite blue, green and red colors; a composite beam of, say, so many watts per steradian of each of these three components, the proportions to be determined by convention based upon experimental results. So far, the proposition is purely academic, a scientific suggestion that appears to be sound. There can be little doubt that if we take three such defined colors and vary their relative intensities, we can arrive at a beam which produces a sensation of white, and we can express the total energy in the beam volumetrically, as watts per cubic centimeter at a given point, or total watts per steradian, when emerging from a virtual point. The energy of each component beam could be measured by the thermopile or bolometer, although the precision of such measurements, as they exist to-day, would have to be improved before the specifications of the proposed synthetic standard could be made satisfactorily precise.

The practical merit of the suggestion, however, lies in the indication of the means, which promise to be practicable, for deriving the three component beams. It is proposed that two mercury-vapor lamps should be used, one in glass walls at a conveniently low temperature, for blue and green rays, and the other in quartz walls, at an enforced higher temperature, for the red rays. It is comforting to know that red rays are to be obtained from a *hot* mercury-vapor lamp, because it has been generally believed that though our sins were as scarlet, they would be invisible by the mercury-vapor light. By means of glass prisms, the green, blue and red beams could be separated out, and adjusted bolometrically to the required standard ratio of intensities. The beams could then have their directions deflected, without other change, so as to mingle on the photometer screen and give us standard whitish light of known volume energy. In order to measure the luminous intensity of some particular lamp, with a different color to that of the standard, translucent wedges would have to be used in the path of one or more of the three component beams, the energy diminutions being subsequently measured. Having arrived at the proper color balance on the photometer screen, and having compared the relative intensities of the two lamps, the absolute light-giving power of the lamp tested could be computed from the relative intensities of the three colors present.

Incidentally, Dr. Steinmetz's paper, above referred to, points out that the ordinary methods of presenting light spectra or curves of luminous properties with respect to wave length are defective and unsatisfactory. Such presentations take as abscissas, either the frequency of the light waves, or their wave-lengths. If the frequencies are plotted as abscissas, we have a relatively great length for all the infra-red rays, then the length for the visible rays, and beyond these all the length to infinity left for the ultra-violet. The visible rays, moreover, occupy only a very small interval on this uniform scale. If, on the contrary, the wave lengths are plotted as abscissas, we crowd all the wave lengths in the ultra-violet into a very small compass near the origin, then take the visible spectrum and leave the length beyond to infinity for the infra-red. Both of these methods are unsuitable. If, however, we imitate the keyboard of a piano in our scale of abscissas, each octave, or doubling of vibration frequencies, or halving of wave lengths, occupies the same distance. In other words, the geometrical scale of abscissas, adopted unconsciously by the pianoforte maker, but scientifically introduced into acoustic literature by Helmholtz, devotes the same length to the octave of visible rays, along the axis of abscissas, that it does to all other octaves, above or below. On the geometric musical scale, all semitones are equally spaced, although the absolute differences between the frequencies of semitones in the bass and in the treble are very different.

On the geometric optical scale, the most sensitive part of the spectrum, i. e., the color to which the retina most powerfully responds, except in very feeble light, is brought near to the center, in the green, near the yellow. There are two big regions, the green and the red, occupying jointly nearly half of the spectrum. There is one region of intermediate length, the violet, half the length of the red, and four short regions, each less than half the length of the red—namely, indigo and blue, yellow and orange. Consequently, we may regard the succession of colors in the geometric scale to be one long region, followed by two short ones—violet, indigo, blue and green, yellow, orange; or we may describe the spectrum on this scale as being composed of three roughly equal long patches, violet at one end, red at the other with green in the middle; while a pair of short intermediate colors intervene between the green and each terminal color. The color octave is thus composed of three tones and four semitones, or 10 semitones in all; whereas, the acoustic octave is composed of five tones and two semitones or 12 semitones in all. A semitone in music represents on the scale of even temperament used by the pianoforte a frequency ratio of the twelfth root of 2; whereas the corresponding even semitone on the color scale would be represented by a frequency ratio of the tenth root of 2.

Program of the National Electric Light Convention.

The annual convention of the National Electric Light Association will be held at the Auditorium Hotel, Chicago, on May 19, 20, 21 and 22. The special train from the East will leave New York on Sunday morning, May 17. The program as now arranged is as follows:

Tuesday, May 19, Opening Session, 10 o'Clock.—President's address; announcements by the secretary; report of committee on progress, Mr. T. Commerford Martin, New York; "Distribution in Suburban Districts," Mr. George H. Lukes, Chicago, Ill.; "Tape," Mr. Paul Lüpke, Trenton, N. J.; report of committee on grounding secondaries, Mr. W. H. Blood, Jr., chairman, Boston, Mass.; "Series Incandescent Lighting with Tungsten Lamps," Mr. P. D. Wagoner, Schenectady, N. Y. Afternoon Session, 2:30 o'Clock.—"Observations on the Precision of Different Types of Photometer," Prof. A. E. Kennelly and Mr. S. E. Whiting, Harvard University; "Power-Load Development for Central Stations of Moderate Size; Some Unappreciated Possibilities," Mr. Charles Robbins and Mr. J. R. Bibbins, Pittsburg, Pa.; "The Small Station and Its Economical Operation," Mr. J. T. Whittlesey, Newark, N. J., and Mr. Paul Spencer, Philadelphia, Pa. Question Box.—Mr. Alex. J. Campbell, editor, New London, Conn.; report of committee on uniform accounting, Mr. H. M. Edwards, chairman, New York City; "Candle-Power Standard"—The presentation of resolutions toward the adoption of an international standard.

Wednesday, May 20, Morning Session, 10 o'Clock.—General meeting; report of committee on gas engines, Mr. W. C. L. Eglin, chairman, Philadelphia, Pa.; "Low-Pressure Steam Turbines," Mr. John W. Kirkland, Schenectady, N. Y.; report of committee on meters, Mr. L. A. Ferguson, chairman, Chicago, Ill.; "Receiving Stations Operated from High-Tension Lines," Mr. S. Q. Hayes, Pittsburg, Pa.; report of committee on organization possibilities, Mr. Henry L. Doherty, New York City; special meeting, Banquet Hall, sixth floor. Parallel Session, 10:15 o'Clock.—"Uniform Accounting and Its Details," open to all accountants and others interested; Mr. H. M. Edwards, chairman committee on uniform accounting, will preside. Evening Session, 8 o'Clock.—Executive session; report of secretary and treasurer and executive committee; report of insurance expert, Mr. W. H. Blood, Jr., Boston, Mass.; report of committee on public policy, Mr. Arthur Williams, chairman, New York City; "The Status and Commercial Possibilities of High-Efficiency Lamps" and Discussion, Mr. W. W. Freeman, Brooklyn, N. Y.; report of committee on rates and costs, Mr. R. S. Hale, chairman, Boston, Mass.; election of nominating committee.

Thursday, May 21, Morning Session, 10 o'Clock; Afternoon Session, 2:30 o'Clock.—Commercial Day.—Mr. C. W. Lee, chairman, program committee, New York City: Mr. Henry L. Doherty, past president, will preside during Commercial Day sessions. 1. Address—"Relationship Between the Engineering and Commercial Departments," Mr. Louis A. Ferguson, past president, Chicago, Ill. 2. Preparation for a Campaign. (a) Field Work and Other Essentials; (b) Analysis of Customers' Accounts; (c) Proportion of Lamp Equivalent Lost to Lamps Connected—Showing Percentage in Cities of Varied Population; (d) Policy of Handling Complaints; (e) Policy of Handling Collections. Editor, Mr. H. J. Gille, Minneapolis, Minn. 3. The Contract Agent and the Representative. (a) The Contract Agent—His Possibilities; (b) The District Representative—His Possibilities; (c) The Special Representative: 1 The Sign Expert; 2 The Power Expert; 3 The Woman Representative; (d) Solicitors' Meetings—Their Objects. Editor, Mr. V. A. Henderson, Memphis, Tenn. 4. The Display Room. (a) Appointments and Methods; (b) Value of Special Demonstrations; (c) Value of Electrical and Food-Show Exhibits. Editor, Mr. L. G. Mathes, Dubuque, Iowa. 5. Advertising. (a) What is Being Done; (b) Why? (c) Results. Editor, Mr. Charles A. Parker, Detroit, Mich. 6. Publicity. (a) Methods to Create Proper Public Sentiment; (b) Dormant Publicity Opportunities of Lighting Companies. Editor, Mr. Percy Ingalls, Newark, N. J. 7. Creating Demand for Electricity. (a) The Creative Principle; (b) Notable Examples; (c) Stereopticon Talk upon Outline and Sign Lighting, Showing Progress in Large and Small Cities. Editor, Mr. Frank B. Rae, Jr., New York City. 8. Evolution of New-Business Building. (a) Examples of Central Stations that Have Continued Methods During Depression; (b) Strong Plea for Up-keep of Commercial Departments and Advertising; (c) Opportunities for Creating Business Along Existing Lines. Editor, Mr. George N. Tidd, Scranton, Pa. 9. The Electrical Contractor. Symposium; (a) What He is Doing to Assist in Creating Greater Demands for Electricity; (b) Specific examples. Editor, Mr. Joseph F. Becker, Jr., Brooklyn, N. Y. 10. "Co-Operative Commercialism," Mr. J. Robert Crouse, Cleveland, Ohio. 11. "Illuminating Engineering as a Commercial Factor," illustrated, Mr. V. R. Lansingh, New York City. 12. Report of committee on solicitors' handbook prize award, Mr. John F. Gilchrist, chairman, Chicago, Ill. 13. Report of committee on co-operative electrical development, Mr. W. W. Freeman, chairman, Brooklyn, N. Y.

Friday, May 22, Morning Session, 10 O'clock.—General meeting; "Illuminating Engineering," Mr. W. D'A. Ryan, West Lynn, Mass.; Report of committee on protection from lightning and other static disturbances, Mr. R. S. Stewart, chairman, Detroit, Mich.; "The Value of Care and Maintenance of Meters," Mr. H. D. King, Hoboken, N. J.; "Some Experiments in Combustion," Mr. S. J. Lenher, New York; "Specifications for Construction on Joint Poles," Mr. Paul Spencer, Philadelphia, Pa.; final report of 1907 committee to consider specifications for street lighting, Mr. W. D'A. Ryan, West Lynn, Mass.; memorials, Mr. T. C. Martin, New York; executive session; report of nominating committee; election of officers for the ensuing year; adjournment. Special meeting, Banquet Hall—sixth floor. Parallel Session, 10:15 o'Clock, Commercial Day.—Unfinished business (if any) from the Thursday session.

Ways to Meet Gas and Gasoline Competition.

In a discussion on the best ways of meeting gas and gasoline competition which was held at the Iowa Electrical Association convention, April 23, Mr. M. A. Harris, of Nevada, Iowa, said that the gasoline-plant salesman will be sure to compare a new gasoline installation with an electric installation of old, blackened incandescent lamps. It, therefore, behooves the central-station manager to see that installations of old lamps are weeded out. In order to meet competition, his company started a day service last July which has not been paying, but he fully expects it to do so. In competing with gasoline for motor business he would install electric motors on trial. They are so much more convenient than the gasoline engine that not a single motor which has been thus installed has been taken out.

Mr. Gus Lundgren, talking on the same subject, emphasized first the importance of good and reliable service to meet such competition. He has been careful to be promptly on hand with emergency break-down service when customers of the gas plants get into trouble. To convince prospective customers that their electric bills would likely not be excessive, he would show them the books giving the bills of various other customers in town. When consumers understand meters they rarely complain about meter readings. It seems well, therefore, to teach consumers to read their own meters.

Mr. Austin Burt stated his belief that a number of satisfied electric-motor customers in town would in time drive out any gas or gasoline engine, so superior is the service rendered. He gave some examples from Waterloo experience to show how badly gasoline engine users at times wish to change to electric service. One customer too far from polyphase feeders to get regular three-phase service finally agreed not to use his motor during lighting hours in order to be permitted to operate a single-phase motor from a lighting circuit which was near the plant.

New Deed of Gift for Edison Medal.

Mr. C. L. Clark, chairman of the Edison medal committee of the American Institute of Electrical Engineers, issues in the current *Proceedings* of the institute an interesting statement as to the terms of the new deed of gift governing the award of the medal. It is as follows:

An important change has been made in the conditions under which the Edison medal is hereafter to be awarded.

The Edison medal was founded upon the initiative of an organization, known as the Edison Medal Association, composed of old associates and friends of Mr. Edison, who subscribed a trust fund for that purpose, under an indenture dated Feb. 11, 1904, and entitled "Deed of Gift Creating the Edison Medal," whereby the institute engaged annually to award the medal "to such qualified student as shall have submitted to the institute . . . the best thesis on record of research on theoretical or applied electricity or magnetism."

No student whatsoever having entered in competition for the medal, although wide publicity had been given to the provisions of the deed by means of appropriate notices, repeatedly sent broadcast to institutions of learning where electrical engineering is taught, the institute became convinced that: (1) the foundation had practically been demonstrated to be a dead letter; (2) the conditions of award under the deed did not properly meet existing circumstances; (3) or insure a general competition by students representing any substantial number of the qualified institutions of learning; (4) criticism of the Edison medal foundation had become general on the ground that it was unusual to award gold medals in the manner provided to young students at the beginning of their careers; (5) the terms of the deed ought to be changed so as to place the award of a medal in the name of Edison on a plane comparable to the award of the John Fritz medal, the Bessemer medal, the Rumford medal, and others of equal renown, whose recipients have been the foremost scientists, philosophers and engineers of their time, and (6) the award ought to be made to bear a distinct relation to achievement in the electrical field.

Thereupon, the Edison medal committee of the institute was directed, in the spring of 1907, if possible to obtain such change in the deed as to make the award dependent upon "meritorious achievement" in the electrical field.

Owing, however, to the legal requirement of obtaining the assent of the 24 surviving and widely scattered members of the executive committee of the Edison Medal Association to the change, and their signatures and seals to a deed embodying the same, it was not until March 26 of the present year that the change was finally consummated in a new deed entitled "Amended and Substitute Deed of Gift Creating the Edison Medal."

By the terms of the new deed, the Edison medal is no longer open for competition, but it is to be awarded "for 'Meritorious Achievement' in Electrical Science or Electrical Engineering or the Electrical Arts," thus placing the award on the high plane where the institute and the Edison Medal Association deem it properly belongs. The award is limited to a resident of the United States and its dependencies or of the Dominion of Canada.

The New York Edison Company and the Tungsten Lamp.

The plan of the Edison Illuminating Company of Brooklyn to supply its customers with tungsten lamps at cost, as reported in these columns last week, will be participated in by the New York Edison Company, which arranged the details with the cooperation of the Brooklyn Edison Company. The plan contemplates furnishing these special lamps at cost, allowing for the present cost of carbon lamps which are supplied free of charge, as noted on page 962 of our issue for May 9.

The company does not incline to the belief that the popularizing of the high-efficiency lamp will mean a loss in energy consumed and a decrease in revenue to the company. At a recent meeting of the New York section of the Illuminating Engineering Society, Mr. Arthur Williams, of the New York Edison Company, stated that a person regulated the use of his light according to his financial condition, and that when improvements are introduced into the lighting field that enabled the consumer to decrease his lighting bill by one-half, instead of taking advantage of this opportunity, the consumer will use two lamps where he had used only one before. Any improvement which decreases the cost of lighting, Mr. Williams concluded, increases the field of lighting and should be encouraged.

Ithaca Section A. I. E. E. Meeting.

Dr. Charles P. Steinmetz visited the Ithaca Section of the Institute last month and delivered an address on "The Alternating-Current Commutator Motor." Dr. Steinmetz's presence and the interest in the topic which he had chosen resulted in an attendance of over 350 persons, and the lecture was stimulating and instructive. He described the various types of alternating-current commutator motor, and explained the difficulties of commutation in such motors. He pointed out that compensation for the reactance and transformer voltages involved is a complicated problem, and showed the latest inventions and devices for insuring satisfactory commutation at various loads and various speeds. The lecturer stated that the alternating-current commutator motor is not by any means new. One of the first tasks upon his arrival in this country in 1889 after joining Mr. Rudolph Eickemeyer at Yonkers, N. Y., was the designing of an alternating-current commutator motor. Prof. Elihu Thomson had two years before invented and patented the repulsion motor.

Dr. Steinmetz, while at Ithaca, delivered a most interesting reminiscent address before the annual dinner of Sibley College, at which about 350 students and members of the faculty were present. The speaker described his early experiences in Germany and Switzerland, as well as his later work with Mr. Eickemeyer, at Yonkers, N. Y. He compared the different fields of electrical engineering, in regard to their relative attractiveness and promise. To say that the students appreciated his remarks is stating the matter very mildly. They were delighted with them, and all present felt that their effect would be lasting as well as stimulating. As a large proportion of the 275 seniors in mechanical and electrical engineering were present, Dr. Steinmetz had an unusually receptive audience. While in Ithaca Dr. Steinmetz on several occasions met the members of the local branch, and everywhere his presence was greatly enjoyed.

Attempt to Defraud Supply Houses.

We are informed that a man giving his name as George Williams and stating that he is connected with the Brenham Compress Oil & Manufacturing Company, Brenham, Tex., has approached several electrical companies, including some dealers in Buffalo, with the evident intention of defrauding them. One of his methods has been to place a substantial order for electrical material, with which he seems to be thoroughly familiar, and after offering checks and referring to his credit with Texas banks, he attempts to borrow money.

Subsequently, it has turned out, that his checks offered in payment are not covered by the local banks in which he claimed he had deposited, or would deposit, money to cover his purchases. The man did not deposit the funds as promised, and used the receipt for the checks in an attempt to secure more material from another dealer.

This man is described as about 5 ft. 9 in., stocky build, weighing about 170 lb., with light hair, blue eyes, smooth face, large, rough weather-beaten features, upper front tooth broken or missing. He wore a soft hat and dressed in general western style.

Proposed Financing of New York Lighting Competition.

The first hearing on the application of the Long Acre Power Company to the Public Service Commission of the First District of New York for permission to issue $10,000,000 par value in preferred stock, non-cumulative and non-voting, with interest at 7 per cent, and $50,000,000 in 6 per cent bonds, took place before Commissioner Maltbie on April 30. The petition asked that $12,000,000 of the bonds might be issued at the present time, secured by a mortgage on the company's property. Mr. J. S. L'Amoreux, of the law firm of Graham & L'Amoreux, appeared for the Long Acre Company. In opposition Mr. Henry J. Hemmens, of the law firm of Beardsley & Hemmens, appeared for the New York Edison Company; Mr. Frank P. Allen for Mr. George E. Corey, a property owner, and Mr. Sterling Pierson for Mr. J. J. Moore. The petition as entered on the records discussed the financial condition of the company, its present plant and the uses intended for the money to be raised, all of which appeared in the discussion of the affairs of the company at previous hearings in the matter of the investigation of the New York electric companies, which have been recorded in these columns. The company presented its case by offering in evidence the record of these previous hearings. In contradiction to the statement made at one of the previous hearings by the Long Acre Company, to the effect that the city was "inadequately" supplied with electric lighting, a letter was offered in evidence signed by Mr. John W. Lieb for the Edison Company, stating that a careful survey of the 393.29 miles of streets in the Borough of Manhattan showed that electric service is now available in 321.46 miles. A survey of the districts to which special reference was made by the Long Acre Company as inadequately supplied, shows that while the total mileage in those districts is 57.62, electric service is available in 46 miles, not including unoccupied subways. The following table was presented:

YEARLY EXTENSION OF STREET MAINS.

1903	56.2	miles
1904	44.5	miles
1905	49.8	miles
1906	54.7	miles
*1907	28.0	miles

*Business depression.

The sale of energy for the year 1907 represents a use to the amount of $7.59 per year for each inhabitant. Comparing the Borough of Manhattan with a population of 2,203,000 for 1907 with the whole metropolitan district of London, with a population more than three times as great, shows that Manhattan used 223,000,000 kw-hours while London used only 213,000,000 kw-hours. The letter stated that the Edison Company had followed a most aggressive policy in extending its activities; by personal solicitation, illuminated signs, monthly bulletins, newspaper advertising, the distribution of circulars and a well-organized "follow-up" system. The increase of new customers' installations from year to year shows an average new gain in candle-power of more than 30 per cent each year for the last five years. The total generating rating in December, 1907, was, including batteries, 186,400 kilowatts, or a reserve rating of nearly 50 per cent above actual demands. More than 95 per cent of the large buildings constructed in recent years are equipped for electric service exclusively from the mains of the company. The company has pursued the most liberal policy, the letter said, in respect to lamp renewals, and is now planning to supply tungsten lamps at actual cost. The letter concluded with the statement that general experience in all large cities and in New York has shown that it is unwise to install and operate duplicate electric-lighting plants, and that under present conditions there is no valid reason for the duplication of investment resulting from the introduction of parallel systems in New York City.

At the hearing on May 5 Mr. Alfred J. Talley appeared in opposition to the Long Acre application on behalf of the Anti-Monopoly Light & Power Company, a corporation organized under New York laws. Mr. Talley alleged that the franchise of the Long Acre Company is invalid, and that the Anti-Monopoly Company is owner of one-half interest in that franchise. He said that last February the Long Acre Company was served with a notice made to the Supreme Court in New York County for the examination of Mr. William H. Kelly before trial, the intention being to commence a suit in equity to establish the title of the Anti-Monopoly Company to the one-half interest in the Long Acre franchise. William H. Kelly was the custodian for several years of a bill of sale or an assignment made by Martin Minturn, who was at one time the owner of the franchise. Mr. Kelly, who, according to Mr. Talley, is a lawyer and former judge, had disappeared from his accustomed haunts coincident with the granting of the order for his examination. Mr. Talley pointed out that Mr. Kelly for some time past had had his office with Messrs. Dittenhoefer, Gerber and James, but no information as to his whereabouts could be obtained at that office. Mr. Talley said that an essential part of the hearing was to establish the validity of the Long Acre franchise, and that if the Long Acre Company officers were acting in good faith they would produce Mr. Kelly, or at least should be in communication with him as an associate in their own office.

Mr. L'Amoreux objected to the filing of the petition on the ground that the subject to which the notice relates is not within the jurisdiction of the commission, but was over-ruled and the petition admitted to the record. The petition was signed by Mr. John L. Walsh, secretary and treasurer of the Anti-Monopoly Light & Power Company, and stated that the company derives its title to one-half interest in the franchise through one of the beneficial owners for whom Martin F. Minturn was an agent and trustee. The hearing was adjourned until May 8.

Grounded Secondaries at Iowa Convention.

Mr. Thomas Sloss, of Cedar Rapids, presented a short paper at the Iowa Electrical Association convention, April 22 and 23, on "Grounded Secondaries." He is strongly in favor of grounding secondary circuits, and said that it will probably be required in the not distant future. He quoted from various authorities, including Dr. C. P. Steinmetz and Dr. Louis Bell, to the effect that the grounding of secondaries is the best method known of protecting consumers from dangerous shocks, and that it should be required. He also quoted from a letter from W. H. Blood, Jr., who represents the National Electric Light Association in matters pertaining to insurance, interests and the National Electrical Code. Mr. Blood in this letter explained that it was agreed by the various interests that it is desirable to ground alternating-current circuits when the maximum voltage between any conductor and ground is not over 200 volts. This question hinges on the maximum voltage from which shocks can be obtained by ordinary persons without injury, and this limit seems to be about 200 volts. For this reason, the committee did not feel like recommending the grounding of circuits having more than 200 volts between a conductor and ground, and recommended further investigation of the desirability of grounding such circuits.

Mr. Sloss said that in Cedar Rapids, the lighting company had grounded all its secondaries for six years past, using copper plates buried in coke. In testing these grounds for conductivity recently, a bank of 12 50-watt lamps in multiple was connected between the non-grounded side of the circuit and ground. In some of the outlying districts these copper plate grounds were found to be so defective that this lamp bank would not be brought up to full incandescence. In such cases the ground plates or wires were found to be nearly destroyed by chemical or electrolytic action. As to transformer breakdowns with grounded secondaries, this company had experienced only two transformer breakdowns in the six years since grounding was the practice—a much better showing than had been obtained before. The question of securing good grounds is an important one. In one stretch of five miles on the interurban line between Cedar Rapids and Iowa City, it had been found impos-

sible to keep ground plates for lightning arresters intact long enough to warrant their installation. A ground, such as his company installs, costs about $10. He pointed to the fact that in case of damages caused by electric shock to consumers, courts have held that the company is responsible if it does not take the well-known precaution of grounding its secondary circuits.

There was considerable informal discussion of this paper, the consensus of opinion seeming to be that there is no question as to the desirability of grounding secondaries if they are securely grounded, the main question being how to secure a good ground, and what is the best kind of ground. As a result of this discussion it was voted to appoint a committee to investigate and report upon the best methods of grounding. The committee appointed for this purpose was Mr. Thomas Sloss, of Cedar Rapids; Prof. T. A. Fish, of Ames, and J. A. Innes, of Eagle Grove.

Mr. J. P. Walters, of Toledo, expressed the opinion that wiring should not be done at or below cost by a company. The difference between wiring at a profit and at cost could not greatly influence the customer, and the profit on wiring would help cover the expense of running service wires to the customer. He thought, however, the plan of allowing consumers to pay for wiring at the rate of $2 to $4 per month was feasible if not gone into so heavily as to cause an undue financial burden on the company.

Mr. Thomas Ferris called attention to the dissatisfaction arising from the poor voltage regulation which prevails among small plants. For example, frequently during the peak load the voltage at consumers' lamps might be somewhere near normal. A little while after the peak, the voltage would be possibly 10 per cent high at some of the lamps, which would make the lamps burn far above normal candle-power. With such conditions, the customer immediately argues that the lamps should be at this high candle-power all the time, and if the company has not equipment enough for carrying the peak load, the result is dissatisfaction. As to introducing tungsten lamps among dissatisfied customers, he thought that the placing of samples for a few nights' trial was the best method of disposing of all arguments.

Mr. Austin Burt said that in electrical, as well as other matters, it was possible to set styles and get people talking about new things. Once a thing came into style, it was easy to get it introduced. Mr. O. E. Brownell, of Lake City, spoke of the feasibility of getting vacuum-cleaning apparatus introduced in a community, both as a source of direct revenue to the company and as a popularizer of electric service. His idea was for a company to purchase a portable electric vacuum-cleaning outfit and rent it to some man who was making a business of cleaning carpets around the town. Mr. Gus Lundgren, of Cherokee, reported that Mr. Grover, of Ames, recently purchased a vacuum-cleaning apparatus to be operated in this way.

Toronto Institute Meeting on Oscillograph.

The regular meeting of the Toronto section of the American Institute of Electrical Engineers was held on the evening of Friday, April 24, in the lecture room of the Engineering Building of the University of Toronto. The chair was taken by Vice-Chairman W. A. Bucke, and the subject of the evening was introduced by Mr. H. W. Price, lecturer in electrical engineering at the university. Mr. Price discussed the oscillograph, showing by means of the lantern the essential characteristics of manufacture and operation. Slides were also shown of oscillograph records of current and voltage taken on the occasion of sundry operations with direct and alternating-current motors. Quite a number of oscillograph records taken on the lines of the Ontario Power Company, at Niagara Falls, were then shown and explained by Mr. Johnson, assistant engineer to that company. Among these records were those of the current in a neutral ground lead of a transformer bank; the phenomena resulting from the use of open fuses as lightning arresters; the operation of an expulsion fuse; charging current of 165 miles of line. One record showed the use of the oscillograph for comparing the speed of two machines.

A short discussion on the uses of the instrument then followed, which discussion was partaken in by Messrs. R. G. Black, P. W. Sothman, H. W. Price, Johnson and W. A. Bucke. The efforts of Mr. Price to make this demonstration an interesting one were very much appreciated by those present.

New Business Methods.

A number of short talks on new-business methods were given at the Iowa Electrical Association convention at Des Moines, April 22 and 23. Mr. L. D. Mathes, of Dubuque, first emphasized the necessity of giving reliable service as a foundation for getting new business. Further than this, prices must be such as to invite the use of electricity by the public. The exhibition of appliances in the company's offices in window displays is a help. He believes in a liberal policy in putting out electrical conveniences on trial, and guaranteeing their satisfactory performance, letting customers try them for a month, or if not satisfied with that, a longer period. Out of a lot of toasters recently put out in this way by his company, only one had been returned, and that by a person who could not use it. The tungsten lamp will appeal to that class of people who have not heretofore been persuaded to recognize quality rather than quantity when they purchased lighting service; in other words, those who are now using gas or gasoline. The tungsten lamp puts the price of electric light down to where it appeals to such users. The introduction of the tungsten lamp among customers already using electricity should result in the use of about the same amount of electrical energy as before, the customer getting increased illumination.

Mr. J. F. Porter, Davenport, in a general review of new-business methods for central-station companies, places newspaper advertising as one of the first essentials in creating a general popular interest in electric service, although yielding but few direct returns in the way of inquiries. The next essentials are solicitation and display or exhibition of devices. He said that it has been demonstrated that an electric company can secure as much business among consumers who already have gas installed as if electricity alone were used. The presence of both illuminants tends to increase the total consumption of energy. This company in Davenport is now maintaining only one outside solicitor and is advertising in the daily papers. He thought that a company in a city the size of Davenport (population about 40,000) could secure power customers up to a size of about 300 kilowatts. Most customers having installations smaller than this could be supplied cheaper from the central station than by themselves.

Mr. A. L. Dodd, of Charles City, also emphasized the necessity for good service if a company is to make progress in getting business. He spoke especially from his own experience at Charles City. When he took hold of the plant, the policy seemed to have been to delay making repairs as long as possible. While he was not an electrician when he took hold of the plant rather against his will, he claimed to be a good enough business man to know that bad service could never make any plant succeed. As an amusing example of some of the troubles under which the plant was laboring, he said it was nothing uncommon for the grates to become so clogged up with clinkers in the middle of an evening's run that a shut-down was necessary to give the fireman a chance to clean the fires. The steam pipes were uncovered so that heat was lost, and there were many leaky joints in the piping. Conditions had been improved so that in the past two and a half years the total interruptions to service added together would amount to less than 30 minutes. An office was established in the business part of town and show-window advertising started. He has now in Charles City (population, 6450) 83 flatirons and 25 fans in service, besides 25 to 30 small motors. He believes in placing complete electric cooking outfits among some families, as this will satisfy a demand that might otherwise spring up for a gas plant.

Discussions on High-Efficiency Incandescent Lamps at the Iowa and Missouri Conventions.

The discussions on tungsten and other high-efficiency incandescent lamps at the electric light conventions of the Iowa and Missouri associations, held during the week beginning April 20, at Des Moines and St. Louis, respectively, resulted in bringing out many points of practical value and interest as to the progress that is being made in the field with these illuminants. At the Iowa convenion a paper by Mr. F. W. Willcox, of the General Electric Company, was read by Mr. George C. Osborne. Mr. Willcox took up the gem, tantalum and tungsten lamps.

The 100-watt gem lamp has largely replaced the 32-cp common carbon-filament lamp. The 125-watt gem has replaced the 50-cp carbon filament, and the 250-watt gem lamp has replaced the 100-cp common carbon filament.

The 50-watt gem lamp has made a good start in replacing the 16-cp common carbon-filament lamp during the past year. This lamp when burning at the highest voltage shown on the label, gives 20 horizontal candle-power, with a useful life of 500 hours or more. At the third or lower voltage the lamp burns at about 16.5 cp, taking 47 watts, with a life of 1000 hours or more. The performance of the gem 50-watt lamps as shown by actual test on large numbers of lamps during the past year, shows that the useful life approximates an average of 500 hours, with a specific consumption of 2.55 watts per candle. As to individual performance, the gem lamps have a slightly higher per cent of early breakages than the carbon lamps, but this is more than made up on the average performance.

The tantalum lamp for direct current shows a saving of over 40 per cent with the same illumination as secured with the 3.5-watt-per-candle carbon lamp. This material gain in economy has given the tantalum lamp a good start in commercial lighting, and over 1,200,000 of the lamps have been sold in this country. This lamp would have had a wider use but for the fact that it was developed about the time of the introduction of the gem filament lamp, which was considerably cheaper and also because its life on alternating current was so short as to restrict it to direct-current circuits. Out of 4000 central stations in this country, less than 300 by number have direct-current service (about 40 per cent in quantity of lamps). Central-station patrons hesitate to adopt a lamp which they have to pay for, when they get free renewals of common lamps, even though a saving or increased illumination can be shown. Most of the tantalum lamps introduced have been of the 50-watt 25-cp, and 40-watt 20-cp sizes. The average life of these on direct-current service runs well beyond the guaranteed figures of 700 hours, many lamps lasting for 1200 hours or more. The 40-watt tantalum lamp is naturally the most popular, since it saves 10 hours over the ordinary 50-watt carbon lamp.

A large part of the tantalum-lamp installations have been on isolated plants, giving relief to overloaded apparatus and giving additional illumination without any increase of equipment. A successful example of its use in central-station work is to be found at Muncie, Ind., a city of 30,000 inhabitants. Over 10,000 50-watt 25-cp tantalum lamps have been put into service out of a total of 32,000 50-watt lamp equivalents connected. A tantalum lamp is sold at 60 cents, as compared to 15 cents for a carbon lamp. About one-half of the tantalum lamps installed are used on a flat-rate basis under a two-year contract.

Tungsten is too brittle to be drawn into a wire. In order to make a filament of tungsten, the fine particles of the metal fiber are made into a paste with some binding material, and this paste is squirted through a diamond die. The filament so obtained is dried, the binding material removed by suitable processes and the particles of tungsten welded together into a continuous wire. To obtain the necessary resistance, tungsten lamp filaments must be long and very thin, which requires special methods of support. The General Electric Company supports its tungsten filaments with a special form of anchor which permits burning the lamp in any position. Although the filament is fragile, this difficulty is being overcome by special methods of packing. The early carbon filaments were as delicate and fragile as filaments of tungsten are to-day. The General Electric Company in the first few months has shipped over 75,000 tungsten lamps to all parts of the country with positive and direct information on most of the packages as to breakage. The results show an average of 1.5 per cent breakage, which compares favorably with ordinary lamps.

It is found that tungsten filaments while burning cannot be readily broken, so that if customers will keep lamps lighted while cleaning lamp, globe or fixture, lamp breakage will be minimized. So far, over 200,000 tungsten lamps of 40-, 60- and 100-watt sizes have been made and sold. The probable supply of such lamps for the ensuing 12 months will be from 3,000,000 to 5,000,000 lamps. This will be enough to enable the central stations of the country to displace some high candle-power gas lamps and take on additional business.

The tungsten lamp is used to the best advantage with the bowl-form of prismatic reflector, particularly with the frosted-tip bulb, which gives a very soft, agreeable lighting effect. From such a unit it is possible to obtain an illumination of 4 foot-candles per watt per square foot upon a plane of 10 ft. to 12 ft. below the lamps, which is four-fold better than the average results from ordinary lamps and shades. It must be realized that the tungsten lamp is not a lamp to replace ordinary lamps everywhere, as it has too large a candle-power and is too brilliant. It must be used in a special way above the line of vision, or, in any event, suitably enclosed in frosted or opal globes or shaded so as to avoid glare. The tungsten lamp has brought about a wholly new condition, as by reason of its very high efficiency it is no longer necessary to depend upon the nearness of the illuminant. A room can be flooded with an almost daylight brilliancy at a reasonable cost with lamps placed well above the view.

Improvements in lamps heretofore have indicated progress, but the tungsten lamp means a revolution in the lighting industry. Its effect will be more far-reaching than even that of the Welsbach mantle. The tungsten lamp can and should be employed primarily to secure new business. Every central-station company should use the tungsten lamp to wean away users of gas or oil. It is not necessary to do anything more than put the lamps in. They will talk for themselves far more eloquently than anything else can for them. In other words, if one will try the "pay-after-you-have-tried-them" plan he will find that he can introduce as many lamps as can be obtained from the manufacturers and hold business permanently with them. Experience has shown that it is desirable for central stations to have as complete control over the lamps used on their circuits as it is possible to obtain. This has heretofore been obtained by the free-renewal policy.

The relatively higher price of the new lamps makes it impossible to supply them on a free-renewal basis. It might be desirable to supply the lamps at a lower price than they could be purchased by the customer in the open market. Several companies have adopted the plan of furnishing the lamps by making a monthly maintenance charge per lamp, after the plan followed for years with high candle-power gas lamps and Nernst lamps. A fair monthly charge for the 100-watt tungsten lamp for an average use of two to four hours per day would be 25 cents per lamp per month. It might be desirable to have this done by a separate maintenance company controlled by the lighting company. The author discussed the feasibility of burning the tungsten lamp at a lower efficiency so as to increase its life to a point where free renewals would be possible. He concludes that it is impractical to do this, as it will necessitate a lamp life of from 3000 to 7500 hours, within which period mechanical lamp breakage would be too large a factor. The diagram herewith shows the cost per 1000 candle-hours to a customer using different types of lamps with rates from 1 to 10 cents per kw-hour.

The tungsten street-series lamp is of equal, if not greater, value than the tungsten multiple lamp in providing profitable

business for central-station companies. These are made in 32-, 40- and 60-cp sizes for several current values from 4 to 75 amp, at a consumption of 1.25 watts per candle. A recent installation of these lamps at Adel, Iowa, shows the following saving secured: The electric-light company installed a constant-current transformer rated at 8.8 kw, 5.5 amp, complete with switchboard panel, with a circuit of 82 tungsten lamps of 40 cp. These replaced a lighting installation of 82 multiple carbon lamps of 32 cp. The saving in energy consumption made the first year paid for the installation of the new apparatus and, in addition, showed a net saving of over $115. The second year the saving, as estimated, will be over $413. This saving is obtained on the basis of 3-cent per kw-hour energy cost and three renewals of lamps per year, as shown by the following statement:

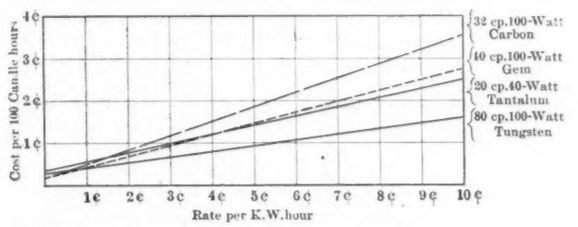
COST OF NEW SYSTEM.

8.8-kw 5.5 ampere transformer and panel	$298.00
246 40-cp tungsten lamps	313.65
Total	$611.65

ANNUAL SAVING OVER OLD SYSTEM.

In energy at 3 cents per kw-hour	$556.50
Cost of 656 32-cp carbon lamps	170.56
Total	$727.06
Cost of new system	611.65
Net saving	$115.41

Comparing the cost of tungsten street lighting with gas, the 40-cp tungsten lamp with its candle-power constantly maintained during life, will match the regular Welsbach street gas lamp, which, while an initial candle-power of 60 is claimed, declines so rapidly in candle-power that its average candle-power is no greater than that of the 40-cp tungsten lamp. The gas mantle using 3½ cu. ft. of gas per hour will burn 14,000 cu. ft. during a year's service of 4000 hours, amounting to $14 with



COST OF LAMPS AND ENERGY PER 100 CANDLE-HOURS.

gas at $1 per 1000 cu. ft., or $10.50 with gas at 75 cents per 1000 cu. ft. Assuming the renewals of mantles in use, repair and attention to lamps as fixed at 3 cents per lamp per night (the figures used in the recent Buffalo contract), the total cost per lamp will be $24.95 with $1 gas, or $21.45 with 75-cent gas. Assuming four renewals per year as a conservative figure for the tungsten lamp at a price of $1.275 each, the renewal cost for the tungsten lamp is about $5. The 40-cp lamp consumes 50 watts, or on the basis of 4000 hours' service, 200 kw-hours per year. Now, the cost of gas and gas-lamp maintenance is $19.50 per lamp above the cost of tungsten maintenance, which amount ($19.50) is available to pay for energy. This $19.50 divided by 200 kw-hours gives a rate of nearly 10 cents per kw-hour to make the cost equal. Central stations could afford to make a materially lower rate than this, and thus be able to effectually compete with Welsbach gas-lamps for street lighting. Central-station companies have great cause for rejoicing over the new developments which will enable them effectually to compete on the basis of cost against cost of other illuminants. Electric lighting has held its own in spite of a serious handicap in cost, and now that it is able to compete on equal terms, the limit of its use is only measured by the capacity of the central-station company to supply the energy.

Mr. George Loring, of the National Lamp Association, Cleveland, discussing this subject, showed that with proper efforts by the central-station company, the introduction of tungsten lamps would tend to cut down the peak load and to increase the load at other than peak periods. For example, in stores, if a merchant cut down his bill for the regular lighting of his store by the use of tungsten lamps he would be likely to listen to a proposition to spend the money saved in this way in lighting after closing time either by electric signs or show-window lighting or by keeping the interior of his store lighted as an advertisement. In this way the company's income per kilowatt would be increased. In residences, he cited an example to show that a similar change could be made. A householder who had heretofore been switching out all lamps and leaving rooms in complete darkness which were not in use, would feel that since electric illumination did not cost so much with the new lamps, he could afford to keep 2-cp or 4-cp lamps lighted in several of the rooms of the house which had heretofore been in darkness when not in use. In fact, the whole tendency would be for the consumer to spend as much or more money for electrical energy used in a different way and spread his demand over more hours per day than formerly.

Mr. George C. Osborne favored the use of the large 100-watt tungsten lamp in store lighting rather than the smaller sizes in most cases because of the lower first cost. As a practical example of what could be done with the tungsten lamp in lowering a consumer's maximum demand without greatly increasing his total consumption, he cited a drug store in Newark, N. J., formerly lighted with 110 16-cp lamps, taking 5.5 kw maximum demand. This was reduced to 1.6 kw by installing 16 100-watt tungsten lamps. This consumer's bills, however, are only about 25 per cent less than formerly because he is so much better satisfied that he is getting his money's worth that he uses a part of the lamps more hours per day than formerly. The tungsten lamp, giving a whiter light, does not appear to such disadvantage in a store partially lighted by daylight as did the common incandescent; hence the consumer has more inclination to use that during the day.

At the Missouri convention at St. Louis, Mr. E. H. Haughton reviewed incandescent lamp development. He described one process of making tungsten filaments as boiling down tungsten oxide with some binder to a kind of plastic mass, which is squirted through a die at heavy pressure. This gives a filament of tungsten oxide, which is treated with certain gases at high temperature and reduced to a metallic state, thus eliminating the binder.

In the practical use of the tungsten lamp he recommended the cleaning of the lamps while burning to avoid breakage. He explained that it is always possible to tell whether a lamp was broken by handling or by being burned out in service. A lamp broken by handling or transportation does not have the filament curled or bent. A lamp burning out in service always has the broken end curled back because of its plastic condition when broken. He said that several schemes to secure careful handling in shipment have been worked out, one of which is to place a bottle with colored liquid exposed in the upper part of the box. The tungsten lamp gives a steadier light with poor voltage regulation than the common carbon lamp. Tungsten lamps burned at less than their normal rated voltage would give a remarkable life.

As to the practical competition of the tungsten lamp with high candle-power gas lamps, he read an extract from a letter from the Citizens' Light & Power Company, of Adrian, Mich. A drug store was lighted with three three-burner gas lamps and also by 24 8-cp incandescent lamps. The cost of operation was $67.69 per 1000 hours. Twelve 40-watt tungsten lamps were installed and gave more light than the gas installation at a cost for 1000 hours with 8-cent energy of $34.96 plus $18 for lamps, making $52.96 for 1000 hours. The National Lamp Association tungsten factories are four months behind orders on tungsten lamps. He commented on the fact that the orders for tungsten lamps from jobbers had been out of proportion to the consumption of ordinary lamps by the same jobbers, showing that many of these lamps are being rapidly sold through small dealers direct to consumers rather than through central stations. He spoke of a 20-watt 16-cp tungsten lamp as one of the future possibilities, in which event small central stations with flat-rate customers would be able to supply these customers at a greatly reduced expense. Mr. George Loring, at the Missouri convention, gave estimates showing that three 100-watt tungsten

lamps could safely be counted on to equal in performance a four-burner gas lamp, and at a 7½-cent per kw-hour rate would cost no more than gas at ordinary figures.

Mr. C. L. Clary, of Sikeston, Mo., believes that the tungsten lamp can be used to decrease a customer's maximum demand without decreasing his bill. He cited one of his store customers who took the money he had saved in store illumination and purchased an electric sign.

Mr. W. B. Hays, of Poplar Bluff, reported that he is displacing gas lamps with tungsten lamps. He sells the tungsten lamps at cost. At the Iowa convention Mr. George C. Osborne said that two 100-watt tungsten lamps would ordinarily replace one high candle-power gas lamp. He mentioned a plan used by F. M. Tait, general manager of the Dayton (Ohio) Lighting Company, who had a pair of booths constructed, one of which contained a high candle-power gas lamp, and the other tungsten lamps properly equipped.

Influence of Load Factor on Cost of Production.

Mr. Austin Burt, of the Citizens' Gas & Electric Company, of Waterloo, Iowa, at the convention of the Iowa Electrical Association, Des Moines, April 22 and 23, gave some interesting information on the operation of the central station of this company, which supplies energy to Waterloo and Cedar Falls. Waterloo has a population of about 20,000 and Cedar Falls has a population of 5319. Mr. Burt showed charts from curve-drawing wattmeters indicating the total load in the generating plant at Waterloo, which showed a remarkably good load factor, due to the large amount of electricity sold to small factories. Mr. Burt presented these and other charts for a period of several years to show what an important influence load factor of a station has on the cost of production per kilowatt-hour. He explained the term "load factor" as commonly used, as the ratio of the average to the maximum load during any given period of time, this factor being usually expressed in the percentage which the average load is of the maximum. The author showed a typical daily load curve for December, in 1907, and also one for December, 1902. The load factor for the month of December, 1902, was about 21 per cent, while that for the

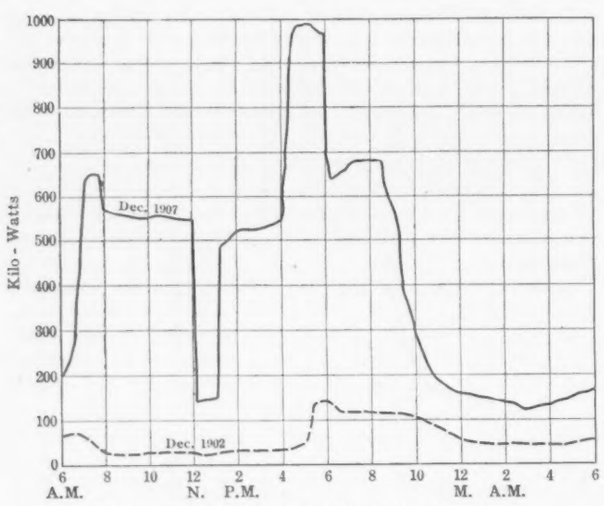


FIG. 1.—DECEMBER DAILY LOAD 1902 AND 1907.

month of December, 1907, was about 37 per cent. The curve-drawing wattmeter charts for April, which he showed, indicated that the evening lighting peak is very little higher than the regular day load, a most unusual condition of affairs in ordinary central-station operation. To illustrate, the practical bearing which load factor may have on operating cost aside from any factors of interest and depreciation, he presented a number of curves. One of these curves shows the load factor for December of each year from 1902 to 1907, and also the load factor of February and March, 1908, which is given for reasons to be explained later. Besides the load-factor curve, there is a curve of average load taking the average load of December, 1907, as 100 per cent. There is also a curve showing the cost of coal per kw-hour in percentage of the cost for December, 1902. The load factor for February and March, 1908, is, of course, better than for December, as would be expected, because the February lighting and power peaks do not overlap to such an extent as those in December. There is a further reason for this, however. The average load curve showed the output for February and March, 1908, to be greater than that for December, 1907, due to taking on power customers. This increase in output for February and March and the increase in load factor acted to bring down the whole cost per kw-hour nearly one-third from what it was in December. Mr. Burt called attention to the importance of maintaining good engine loads in small stations; that is, having engines for operating during the long light-load period of the day of a small enough capacity so that they would not run greatly underloaded.

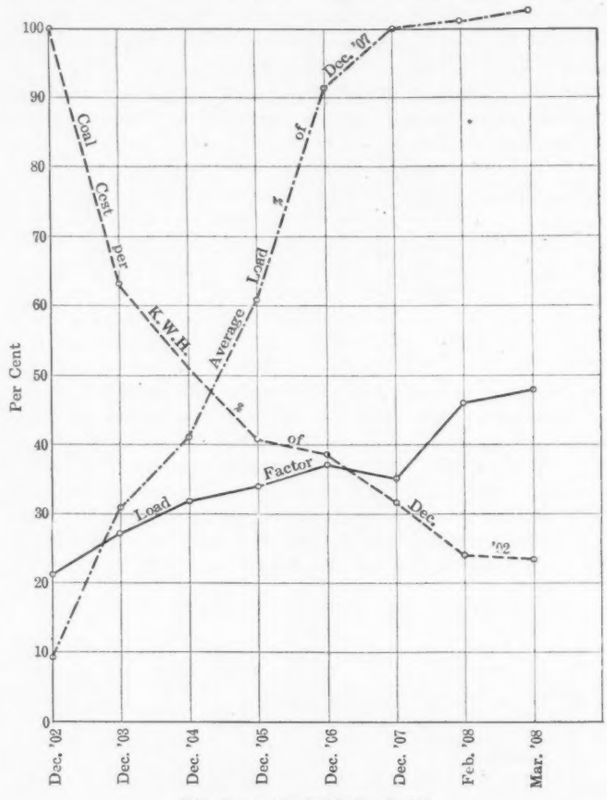


FIG. 2.—LOAD FACTOR CURVE.

Popularizing the Use of Electricity.

A paper on the above subject was given before the Iowa convention, April 22, by Mr. E. L. Callahan, heating appliance specialist, of the General Electric Company's Chicago office. The author discussed electric-heating devices and the sale of energy during daylight hours. He said that all of the business that a company takes may be profitable in the long run, but some of the load connected is more profitable than the rest. The motor business is usually profitable and the sign business is also profitable, but the latter comes heavily on the lighting peak and does not draw on the plant at all during the daylight hours. The residence lighting business is gleaned from an immense territory covered by a network of expensive copper and line material. In small cities approximately 95 per cent of the residences are not wired, and in large cities about 98 per cent are not wired. He called particular attention to the electric heating appliances with which a day load could be built up quickly. The flatiron is the best-known electric device and the easiest to

introduce. He then gave the following list of tested recipes for increasing dividends by means of electric irons:

First—Select the best young lady or young man salesman in your employ or to be found in town (you may need four or five of them), either to give all or a portion of his or her time to your residence customers, following up inquiries on heating and making a thorough house to house canvass of all residences wired and taking time to demonstrate the use of the iron thoroughly.

Second—See that an electric iron is included in contractors' bids for wiring of each residence so that when a meter is set an iron is installed.

Third—Arrange with one of your newspapers to have an iron offered as a premium or at a reduced price with each new subscription. (The Chicago *Examiner* is doing this and expects to place 25,000 within a year.)

Fourth—Obtain from your nearest college, university or high school a young woman or young man recommended as a hustler to solicit, install and perhaps collect for irons at a commission of 50 cents to $1 per iron.

Fifth—Secure from the manufacturer of the irons an expert solicitor to call and demonstrate the iron at each residence, leaving the iron on trial; then follow up the work by telephone, letter or by call of your solicitor when necessary.

Sixth—On each Saturday, if the day be warm, take out a load of irons and distribute them on trial—probably very few will be returned.

Seventh—Rent the iron for 25 cents per month or loan it for a period of one year, customer paying a deposit of practically cost which is returnable with interest.

Electric cooking has appealed to people who have longed for some means of cooking with absolute cleanliness. It is safe to say that because of widespread advertising and the progressiveness of the times, you can quite easily persuade many of your customers to use electricity for all their cooking.

The amount of profitable cooking load that you can take on your lines depends upon local conditions entirely.

The size of the city or town has much to do with whether a portion or none of this load comes upon the lighting peak. In summer time and in small cities and towns I do not believe an appreciable amount of the load will come on the peak, for the days are long and dinner is eaten at noon. In large cities perhaps 25 or 30 per cent of this cooking load would be noticeable on the peak, but, even so, it is encouraging to see that these lighting companies are planning to take care of it.

There is a very substantial revenue to be obtained from use of the various so-called "lamp-socket devices." The coffee percolator and the toaster should be used in the home every morning. The revenue will amount to more than that from the use of a flatiron for the week's ironing. Then there is the shaving cup, water heater and baby milk warmer, all of which help.

In the discussion of this paper, Mr. L. D. Mathes, of Dubuque, said that he thought the central station should co-operate with the local supply dealers and protect them as to prices. At one time the supply men in Dubuque did not carry a stock of irons and similar electrical conveniences, and the central station began the sale of these devices at nearly cost. He later became convinced that this was not best, and that the supply men should be given a chance, so the price on these devices was put up so that the supply houses could carry them. On flatirons the profit was restricted to 50 cents per iron.

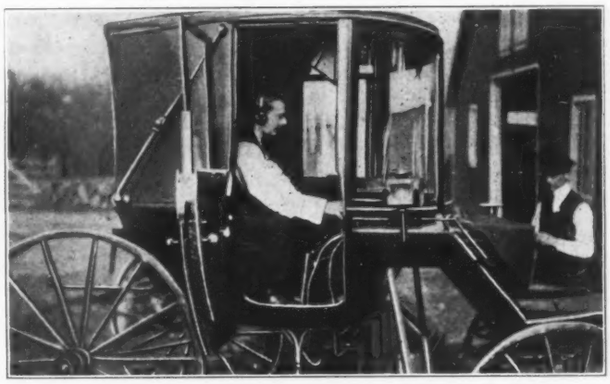
Mr. Austin Burt, of Waterloo, raised the question whether it would be feasible for a very small station which was not giving day service to arrange to operate during the day on Tuesday to supply energy for electric irons. Mr. Thomas Ferris raised the question whether it would pay to operate such a plant until 8 o'clock every morning to supply toasters and breakfast cooking utensils. Mr. Thomas Crawford, of Clinton, said that finances stood in the way of the operation of day circuits by many small companies, not so much because of the operating expense as because the operation of such circuits would immediately require extension of lines and increased investment for which the capital could not be obtained. He thought a day circuit would usually pay in a town of 1500 inhabitants and over.

Mr. Austin Burt thought that the existence of numerous flat-rate customers had prevented the operation of day circuits in small towns. His company, when it began to operate day circuits in Cedar Falls, placed all flat-rate customers on a meter basis. This change brought in enough more gross income to pay for maintaining the day service.

Mr. H. A. Zinn, of Anamosa, reported 30 per cent of his customers on flat-rate schedule before day service was given. When day service was begun, most of these were placed on a meter basis because of the improved service to be given, so that now only about 8 per cent were supplied with energy on a flat rate. This change was satisfactory to customers because of the fact that they were getting day service. Mr. G. Deiderich, of Avoca, asked as to the policy of installing meters for customers having only two or three lamps where the cost of a meter was hardly justified. Mr. Burt reported that his company took nothing less than a four-lamp consumer; that is, charged no rates less than those based on four lamps.

Reporting the Briarcliff Races by Wireless.

The entire progress of the 240-mile automobile race, April 24, at Briarcliff, Westchester County, New York, was reported to the Times Building, in Long Acre Square, by wireless telegraphy, using the Marconi system. One minute after Strang shot across the finishing line a winner, the crowds who blocked Broadway saw the announcement posted on the *Times* bulletin board, from five to 10 minutes ahead of the telephone and telegraph. The credit for this latest application of the wireless belongs to the Lozier Automobile Company, which backed the project and made the arrangements with the *Times* for reporting the race. The main wireless station, put in place during the week before the race, was at Briarcliff Lodge, a hotel situated on an elevation about half a mile from the grandstand and finish line. Transmission and receiving wires were strung from a corner basement room in the hotel to the top



TEMPORARY WIRELESS STATION NEAR MT. KENSICO CEMETERY.

of a steel water tower, 106 ft. high, which stood near at hand. The operator sat in the basement room and received the dispatches for transmission over a temporary telephone line connecting with the grandstand. This station was equipped with a ½-kw outfit. Eight miles distant, directly across and half-way round the course, near Mt. Kensico Cemetery, was a second station or substation, with a slightly smaller equipment, which reported the progress of the race to the main station at Briarcliff. The main station obtained energy from the alternating-current lines of the private plant at the hotel, and the substation was operated by 16 storage cells. In place of a wireless mast, an old windmill tower, 50 ft. high, was pressed into service at the substation. As there was no building available at hand it seemed that the operator would be obliged to sit on the ground until the proprietor of a small livery stable near the cemetery, after having refused to loan the hearse in his charge,

offered the use of an old, broken-down stage coach which had been used for years at negro funerals. The coach was hauled near the windmill directly by the side of the course. The accompanying illustration shows the operator sitting in the coach with the sounder before him and the storage batteries under the coach with the wires running up through its rickety bottom. Transmission and receiving wires were strung from the flag pole on the top of the Times Building, and the operator, sitting in a small room in the tower, telephoned the results to the bulletin-board man stationed on the ground floor.

Nebraska Electrical Association Convention.

The Nebraska Electrical Association, which was organized about a year ago, held its first annual convention at Omaha May 6 and 7, 1908. The active membership of this association consists of electric lighting companies, of which over 20 out of the 60 companies in the State were represented, some companies sending several men. This remarkable showing at the first annual convention verifies the truth of a statment frequently made, that the farther West one goes, the larger the percentage of companies which are enterprising and progressive enough to be represented at State conventions of this kind.

The first session of the convention was opened Wednesday morning at the Omaha Auditorium, where the Omaha Electrical Show was in progress. The following three sessions were held at the Millard Hotel, which was association headquarters. President T. H. Fritts, of Grand Island, presided over most of the sessions; Vice-president R. D. Russell, of Fairbury, occasionally acting in his place.

In the president's address at the first session, Mr. Fritts called attention to the fact that the association met with 25 members on its roll at its first annual convention. Among the principal things of general interest which he called attention to were municipal lighting, accounting, depreciation in private plants, wiring inspection in the State, and the radical changes about to be caused by the tungsten lamp. He brought out the well-known fact that statements made as to costs of production in municipal plants were seldom correct, because all costs were not included. This was especially true when the plant was run in connection with the waterworks, and the waterworks was saddled with expenses really belonging to the lighting plant. On the question of depreciation, he said that this item was not being sufficiently considered in connection with either private or municipal plants. Probably sooner or later, to judge from the general sentiment of the public, State regulation of electric light companies would be put in force. In preparation for the time when strict accounting must be made to a commission, companies should begin to write off proper depreciation reserves. He thought that the inspection of electrical wiring by competent men is to be encouraged, and recommended the appointment of a committee on inspection. He favored State inspection of electric wiring.

A nominating committee of five was appointed as follows: Messrs. L. J. Schwengel, of Holdredge; S. E. Schweitzer, of Omaha; L. E. Watson, of Beatrice; E. J. Sullivan, of Omaha, and J. M. Roberts, of York. The president's address was referred to a committee of three, consisting of Messrs. W. P. Byron, of Gothenburg; W. B. Stark, of Fremont, and J. M. Roberts, of York. Mr. E. J. Sullivan, of Omaha, secretary of the Beatrice Electric Company and of the Electric Service Company, of Wymore, introduced a resolution which, if passed, would admit municipal plants to membership in the association.

This resolution was discussed at length at this and other sessions, and was finally passed without a dissenting vote. Both sides of the question were thoroughly brought out in the discussion. It was pointed out that against this action was the indifference and incompetency of many men responsible for the conduct of municipal plants, and that the misrepresentations of true costs, both wittingly and unwittingly, made by those connected with municipal plants, had aroused a feeling of hostility against municipal undertakings among those connected with private electric lighting companies. It was therefore urged that it would be difficult to conduct an association in which both private and municipal plants were represented. On the other hand, in favor of admitting municipal plants, it was pointed out that in a great many cases those connected with municipal plants, if brought into the association, would come into closer touch with the men and mehods of private plants, and vice versa, to the benefit of all concerned; and that the ideas and education thus received would tend to make municipal plant managers figure true costs of service and to check the circulation of the absurd figures on costs of production which had aroused bad feeling between municipal and private plant managers in the past. It was pointed out that the Minnesota and Michigan associations admit municipal plant superintendents. It was also pointed out that as long as the hostile spirit exists of fighting blindly everything connected with municipal ownership by private companies, little progress can be made in bringing to light the true state of affairs as regards municipal and private undertakings.

Wednesday afternoon Mr. Waldemar Michaelsen, city electrician of Omaha, read a paper on "The Duties of the Electrical Inspector," which brought out a very complete discussion. Further consideration of the matter, however, was left until the following morning, when the insurance committee announced that Mr. W. S. Boyd, of Chicago, representing the National Fire Underwriters, would be at the convention the next day to take up the subject of "Electrical Inspection in the Smaller Cities." Following this discussion, Mr. V. W. Bergenthal, of the Wagner Electric Manufacturing Company, St. Louis, read a paper on "The Motor Problem from the Standpoint of Small Central Stations." In this he outlined the legitimate fields for various types of single-phase and polyphase motors. This paper was discussed the next day, as the association had accepted an invitation for 4:30 p. m., tendered by Mr. H. A. Holdrege, general manager of the Omaha Electric Light & Power Company, to take a special car and visit the modern plant of the company. The convention, therefore, adjourned promptly at 4:30 to do this and were taken to the power house, which is an excellent example of modern steam engineering practice. The latest units installed are two 2500-kw Curtis turbo-alternators.

In the evening the Omaha Electric Club tendered the convention a banquet at the Henshaw Hotel. The arrangements were made in excellent taste. Mr. E. J. Sullivan, in the dual capacity of an Omaha supply man and member of the Electric Club and as a Nebraska central-station man, acted as toastmaster. The following toasts were responded to, interspersed with music from an excellent quartette; "How It Feels to Be the Pioneer," George W. Johnston; "The Points of Similarity in a Threshing Machine and an Electric Light Plant," E. A. Bullock; "Contractors and Their Relation to Central Stations," E. F. Schurig; "The Branch of the Business I Have Not Yet Covered," F. H. Brooks; "The Association and Its Benefit," I. A. Campbell; "What I Don't Know About Inspections," W. Michaelsen.

Thursday morning the executive committee's report and secretary's report were read. The secretary's report showed 23 central stations as having joined since the organization up to May 1, 1908; and a number had applied during the convention. Mr. W. S. Boyd, representing the National Underwriters, then addressed the meeting at length on insurance inspection, especially with reference to small cities. Mr. E. J. Sullivan, of the insurance committee, announced before this address that the committee had been meeting with Mr. Boyd and that on some points they agreed, while on others they disagreed. He asked that the insurance committee be continued, which was done. Following Mr. Boyd's address, there was an extended and at times a very warm discussion over some of the points raised, but no satisfactory solution was offered of the question as to how wiring inspection and good wiring could be secured in small cities, unless the central-station company takes the matter in hand for its own protection.

Thursday afternoon the discussion of Mr. Boyd's address was taken up again. This was followed by a talk on "Meeting Gas

and Gasoline Competition," by Mr. J. R. Cravath, Western editor of the ELECTRICAL WORLD. This took up principally the use of the tungsten lamp; the illuminating engineering connected therewith; a table showing for comparison the tungsten lamp illumination together with gas mantle burners and gas arcs; and the business policy to be followed both as to rates and as to installation and maintenance of tungsten lamps.

Mr. I. B. Zimman, contract agent of the Omaha Electric Light & Power Company, gave a short paper on rates, in which he took up principally the two-rate system which automatically takes care of readiness-to-serve charges and gives the long-hour user a low rate. This brought out considerable discussion. The rest of the session was taken up with the question box.

The officers elected were: President, Mr. E. A. Bullock, of Norfolk; vice-president, Mr. S. J. Duncan, of Kearney; secretary, Mr. Wm. Bradford, of Lincoln; treasurer, Mr. L. J. Swengel, of Holdredge.

Zoelly Steam Turbine.

In a report to the Department of Commerce and Labor, special agent Capt. Godfrey L. Carden gives full details concerning the Zoelly steam turbine, manufactured by Escher, Wyss & Company, of Zürich, Switzerland. The turbine is of the parallel-flow "simple action" type with pressure stages and with a minimum number of stages of 9 or 10. It differs from the reaction turbine in several essential points. The steam enters the turbine wheel with its pressure preserved and is not lowered in passing. As there is neither axial thrust nor leakage, a large radial clearance can be allowed between the turbine wheels and stationary parts. In this new Zoelly steam turbine, which may also be described as a simple-action turbine, the steam jet from each guide apparatus acts on one wheel only. The steam on being admitted to the turbine passes on to the first guide apparatus, in which it is partially expanded, and so acquires kinetic energy, and is further directed at the proper angle to the running wheel, which absorbs the energy corresponding to the first expansion. The steam then passes to the second guide apparatus, where the second expansion takes place, and in like fashion the steam works through all the wheels and passes out to the exhaust pipe. Each guide apparatus consists of a disk divided along its horizontal diameter, and is made of cast steel or cast iron in one piece with a distributing ring. The blades are of nickel steel, and the whole apparatus is very solid in construction. The construction of the runners appears perfected to a high degree of reliability. Each turbine wheel disk is made of high-grade steel forged in one piece at the boss, and is carefully turned and polished all over. The blades are thickened toward the center in order to make the stress of the metal the same at every radius.

The Zoelly turbine has only about one-third to one-fifth the number of blades of a multi-stage reaction steam turbine of the same output, and the average velocity of the steam being low the wear on the blades is not appreciable. Captain Carden says that this turbine seems to be regarded in high favor in Germany, and is especially commended by reason of the little care and attention that are necessitated. He has seen one of these turbines working under very low pressure, utilizing, in fact, exhaust steam, at one of the colliery pits, and as the engine requires no extensive warming up before starting, it is valuable as a reserve machine.

Escher, Wyss & Company are building turbines of this type for a 20,000-hp German scout cruiser, two of 6000 hp for outboard screws and two of 4000 hp for inboard screws. Turbines have also been designed for two torpedo-boat destroyers, one of 9000 hp and another of 14,000 hp, the machinery to be built by the German and French governments respectively. Krupp has obtained the Zoelly turbine rights for Germany, Schneider, of Creusot, for France; Orlando & Company, of Leghorn, for Italy. The Russian government is also about to take up this type of turbine. The American rights have not yet been disposed of.

Escher, Wyss & Company are also bringing out a liquid-fuel heating system for marine boilers. This involves a steam turbine-driven turbo-compressor of the Zoelly type. The use of liquid fuel, it is pointed out, calls for compressed air at about 14 to 15 lb. per square inch, to be forced through suitably dimensioned nozzles placed over the grates. It is not practicable to use reciprocating engines for this purpose, owing to the reduced floor space of stoke holes, and to overcome this difficulty Escher, Wyss & Company have bought out the Zoelly type of turbo-compressor driven by a Zoelly steam turbine. The system can be operated in any position that may be required by ship conditions.

Electric Light Association for Pennsylvania.

A movement toward forming an association of electric light companies in the State of Pennsylvania was started last fall by Mr. L. H. Conklin, general superintendent of the West Penn Electric Company, headquarters at Connellsville, Pa., who sent a circular letter to all the companies in the State asking them if such an organization would be desirable. The number of replies received was encouraging, and a "follow up" system was inaugurated to interest corporations in the organization of such an association. A meeting was called at Harrisburg Jan. 15, but only those companies were asked to attend that had responded favorably to the circulars sent out. This resulted in 10 companies sending representatives, and as this was so small a percentage of the companies in the State, it was not deemed wise to organize a permanent organization with such a small representation. Hence, a temporary organization was effected, whose officers were elected until such time as the executive committee thought it wise to call another meeting for the purpose of a permanent organization. At that meeting, the temporary officers were to vacate and the permanent officers be elected in their stead for a period of one year. Since that time, a systematic effort has been made to interest the companies in this association, and the results have been remarkably good.

Realizing the fact that the matter of associations has been rather overdone, it was deemed advisable to follow this up with explanations of the reasons why a State association was often of more particular benefit than a general association, due to the fact that they deal with local conditions, all having to figure on the same laws and legislative body, together with many other reasons, not the least of which is the social enjoyment of knowing one's neighbors. The results of this campaign, which has been carried on somewhat intermittently, have been that there are at present 23 member companies regularly enrolled and at least a dozen others which have signified their intention of joining. Among the companies enrolled are the very largest in the State and also some of the smaller ones. The idea seems to be well received and the chances for continued success are very bright.

The meeting for the permanent organization will probably be called some time during the coming summer, at which time, it is fully expected, at least 50 companies will have enrolled. The officers of the temporary organization are as follows: President, L. H. Conklin; vice-president, E. F. McCabe; secretary and treasurer, E. L. Smith; members of executive committee, E. H. Davis and A. R. Granger.

International Telegraph and Cable Conference.

Advices from Washington state that the Department of Commerce and Labor has been advised by cablegram from Special Agent Dennis, who is in attendance as representative of the United States government upon the international telegraph conference, now in session at Lisbon, containing important information that business interests are not to be disturbed by a serious curtailment of the right to use codes in international cabling. The cablegram reads as follows:

"Tone of the conference is not strongly antagonistic to the large majority of existing code regulations. There is a feeling

to prevent the use of unpronounceable combinations of letters now being supplied by codemakers. The British postoffice circular issued to Chambers of Commerce reads in part:

"'The Postmaster General thinks it desirable that the condition as to pronounceability be somewhat more clearly defined in order to put some limit for the future to a growing tendency which, if unchecked, cannot fail to produce results highly injurious to the telegraph service generally, and therefore to the public and to commerce.'"

There is, however, no intention of adopting other than a wide and even generous interpretation which would cover the bulk of the codes at present in use.

A press dispatch states that Belgium has proposed a modification of the present system of counting words whereby the existing distinctions regarding plain, conventional and code language is to be abolished and a uniform word of five letters or five figures substituted. This proposition met with strenuous opposition from the commercial interests of Great Britain and America.

CURRENT NEWS AND NOTES.

NATIONAL FIRE PROTECTION.—The twelfth annual convention of the National Fire Protection Association is to be held at Chicago on May 26, 27 and 28 in the assembly room of the Chicago Board of Underwriters, National Life Building. A number of interesting reports will be presented as usual.

N. E. L. A. RECEPTION.—The regular program for the Chicago convention of the National Electric Light Association is given elsewhere in this issue. The meeting will be preceded by the formal opening on Monday evening, May 18, of the manufacturers' exhibition, and this in turn will be followed by a reception given by the local reception committee in the beautiful new gold banquet room on the second floor of the Auditorium Hotel Annex. Immediately after the reception there will be dancing and supper will be served.

PUBLIC UTILITIES OF INDIANA.—Mr. B. V. Hubbard, of Mooresville, Ind., who was elected president of the Public Utilities Association of Indiana at the time it was organized in December, 1906, has recently recovered from an illness of over a year. We are informed by Mr. Hubbard that a meeting of the Public Utilities Association of Indiana is called for Tuesday, May 12, at the Palm Room of the Claypool Hotel, Indianapolis. Every gas, electric, water and telephone company in the State is invited to send representatives to this meeting and to join the association.

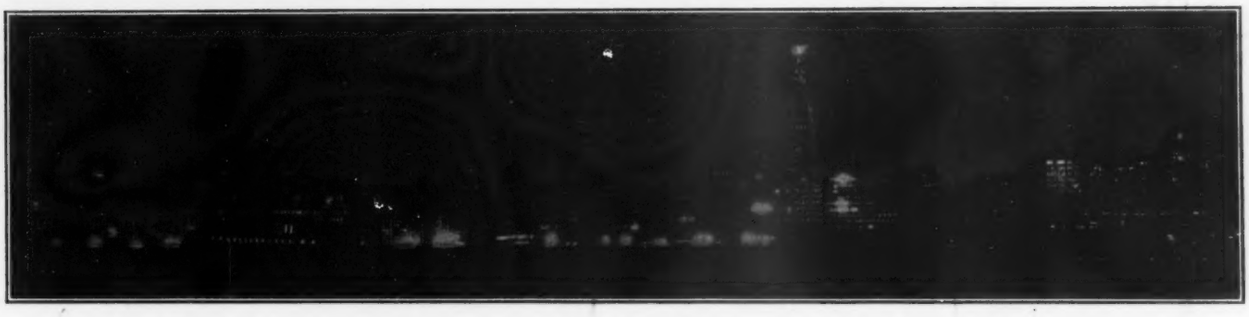
WARNING OF FRAUD.—We have had to call attention during the past five or six years, upon various occasions, to the fraudulent practices of a young man about 30 years old, 5 ft. 8 in. high, slender build, light complexion, crooked teeth. He speaks with an English accent, claims to be connected with various important men engaged in the electrical or mechanical field in England, generally has a hard-luck story, and borrows money which is never returned. He is using a number of aliases and has operated all over the country. We are informed that he is at present in New York, has been recently heard from in Philadelphia, Rochester and other Eastern cities; and our readers are hereby warned against him.

INSTITUTE OF CHEMICAL ENGINEERS.—We are informed by Mr. W. M. Booth, of Syracuse, N. Y., that after nearly a year of deliberation the committee on a proposed engineering society for practical chemists has decided to request the principal technical journals to state that the committee appointed at Atlantic City last June to consider the formation of an American Institute of Chemical Engineers has found, after obtaining the views of the chemists of this country, that there is a strong sentiment for bringing together into closer relationship those men who more particularly specialize in chemical engineering. A very decisive vote has been received in favor of the formation of the society. It has been decided to call a meeting for the purpose of organization. This will be held in Philadelphia some time during the middle of June. Several men eminent in the profession have consented to address the meeting.

TIME ON TELEGRAMS.—At Washington, on May 5, Mr. George H. Fearons, general attorney for the Western Union Telegraph Company, addressed the House Committee on Interstate and Foreign Commerce in opposition to the bill introduced by Mr. Carey, of Wisconsin, to require telegraph companies to transmit with telegrams the time of filing messages and the time of putting them on the wire. Mr. Fearons said that 60 per cent of the telegraph business of the country was the transmission of information for exchanges, boards of trade and similar commercial bodies; 20 per cent was newspaper matter; 15 per cent railroad intelligence, and less than 3 per cent "private and social telegrams." He said that on the basis of 74,805,000 telegrams transmitted annually, the additional number of words imposed by the bill upon the Western Union Company for transmission would be equal to 17,454,000 10-word messages. This means 174,540,000 words unnecessarily transmitted, clogging the wires and delaying service.

ELECTRIC RAILWAY JOURNALISM.—The McGraw Publishing Company announces that it has purchased from The Wilson Company the *Electric Railway Review*, and that this periodical will be combined with the *Street Railway Journal*. The first issue of the consolidated publication will be dated June 6. It will be known as the *Electric Railway Journal* and will be published from the main office of the McGraw Publishing Company, at 239 West Thirty-ninth Street, New York. In addition, the publishers maintain editorial and business offices at Chicago, Cleveland, Philadelphia and London. The McGraw Publishing Company will carry out by means of the *Electric Railway Journal* all unfilled subscriptions to the *Street Railway Journal* and the *Electric Railway Review*. The subscription price for the *Electric Railway Journal* will be $3.00 per year. The consolidated paper, with its broadened field and range of vision, will combine all that is best in each of its former constituent elements, and will certainly be of greater usefulness and benefit to the art and industry than was possible under the old conditions. The great electric railway development will have a weekly publication worthy of it and able adequately to record its every aspect.

OMAHA ELECTRICAL SHOW.—The electrical show which was held in the Omaha Auditorium, May 4 to 9, resulted in a local interest far beyond anything anticipated. The attendance, which ran over 2000 per evening, taxed the capacity of the exhibit space and aisles, and dispelled any doubts as to the desire of the Omaha public to investigate electrical matters. The central feature of the show was a cottage full of things electrical, erected by the Omaha Electric Light & Power Company, in charge of Mr. I. B. Zimman, contract agent of the company. The show was carried out by the Nebraska Electrical Trades Association, of which Mr. E. J. Sullivan, of the Nebraska Electrical Company, Omaha, is president, and William L. Burgess secretary. The Omaha Auditorium, where the show was held, is under the management of Mr. J. M. Gillan, who arranged many of the details. The leading local supply houses were represented. The cottage of the Omaha Electric Light & Power Company was lighted in good taste at a very moderate expenditure in fixtures to illustrate a typical simple lighting scheme for a small building of this kind, rather than to make an elaborate fixture display. The general lighting of several rooms was accomplished with a frosted-tip tungsten lamp placed at the ceiling in the center of the room, equipped with an enameled bowl reflector, so that nothing but softened and diffused light could reach the eye. In the bedroom, brackets on each side of the dressers were provided with frosted diffusing globes over carbon lamps. All of the common heating appliances and electrical conveniences were shown in each room in their proper places.



NIGHT VIEW OF CHICAGO FROM LAKE FRONT.

The System and Operating Practice of the Commonwealth Edison Company, Chicago.

PRACTICALLY all of the central-station electric lighting and industrial service in Chicago, except that for street lighting, is furnished by the Commonwealth Edison Company. This company, which is the result of various consolidations, has a franchise covering the entire city. Besides furnishing electricity for lamp and motor service, the company also sells a large amount of energy at wholesale to street and elevated railway companies and to interurban railways. There have been no important extensions or enlargements of electric railway generating plants in the city of Chicago in the past five years, with the exception of one elevated road. The increase of business on the railways and the change from cable to electric traction on the principal street railway lines has been entirely taken care of by the purchase of energy from the Commonwealth Edison Company.

Although isolated plants are still numerous in Chicago, they were never so hard-pressed by central-station service as now, and the Commonwealth Edison Company has among its customers establishments formerly run by some of the largest isolated plants in the city. In the past five years there has been a material advance in the supply of energy to such large consumers. The manufacturing districts also have been invaded and all-day motor load secured. The residence districts are being much more thoroughly covered than a few years ago. These railway, manufacturing and residence lighting loads are having an important influence on the company's load factor.

EQUIPMENT OF STATIONS.

The peak-load generating output of the company aggregates 119,250 kilowatts in three stations. Of this total 98,250 kilowatts is in the Fisk Street station, 18,000 kilowatts in the Harrison Street station and 3000 kilowatts in the Fifty-sixth Street station. These generating plants transmit energy to 33 substations belonging to the Commonwealth Edison Company and 11 substations belonging to various railway companies. The rotary-converter rating connected to the 115-volt and 230-volt direct-current network in the central part of the city aggregates 50,700 kilowatts. The alternating-current motor-generator frequency-changer sets, through which 60-cycle energy is supplied to the outlying alternating-current districts, aggregate 21,340 kilo-

FIG. 1.—TURBINE ROOM OF FISK STREET STATION.

watts in rating. The rating of the rotary converters in the substations of the railway companies aggregates 50,400 kilowatts, and there is one railway motor-generator of 500 kilowatts. The total equipment of rotary converters and motor-generators connected to the system has a rating of 122,940 kilowatts. The Commonwealth Edison Company at various substations has storage batteries for discharging into its direct-current network which aggregate 18,030 kilowatts in output at a one-hour discharge rate. The railway companies also have batteries aggregating 4856 kilowatts at a one-hour rate.

GENERAL CHARACTER OF THE SYSTEM.

The Commonwealth Edison Company furnishes direct-current energy at 115 and 230 volts in the central part of the city, and 60-cycle, 115- and 230-volt single-phase, alternating-current energy for lamps and for motors rated up to 5 horse-power, and three-phase alternating-current energy for motors rated above 5 horse-power.

The greater part of the output is generated at 9000 volts, 25 cycles, three-phase and transmitted to substations. Substations for direct-current energy distribution contain step-down transformers and rotary converters. The substations for alternating-current energy distribution contain motor-generator frequency-changers, which receive three-phase, 25-cycle, 9000-volt current and deliver 60-cycle current for four-wire, three-phase energy distribution with 2200 volts between each phase wire and neutral, and 3800 between phase wires.

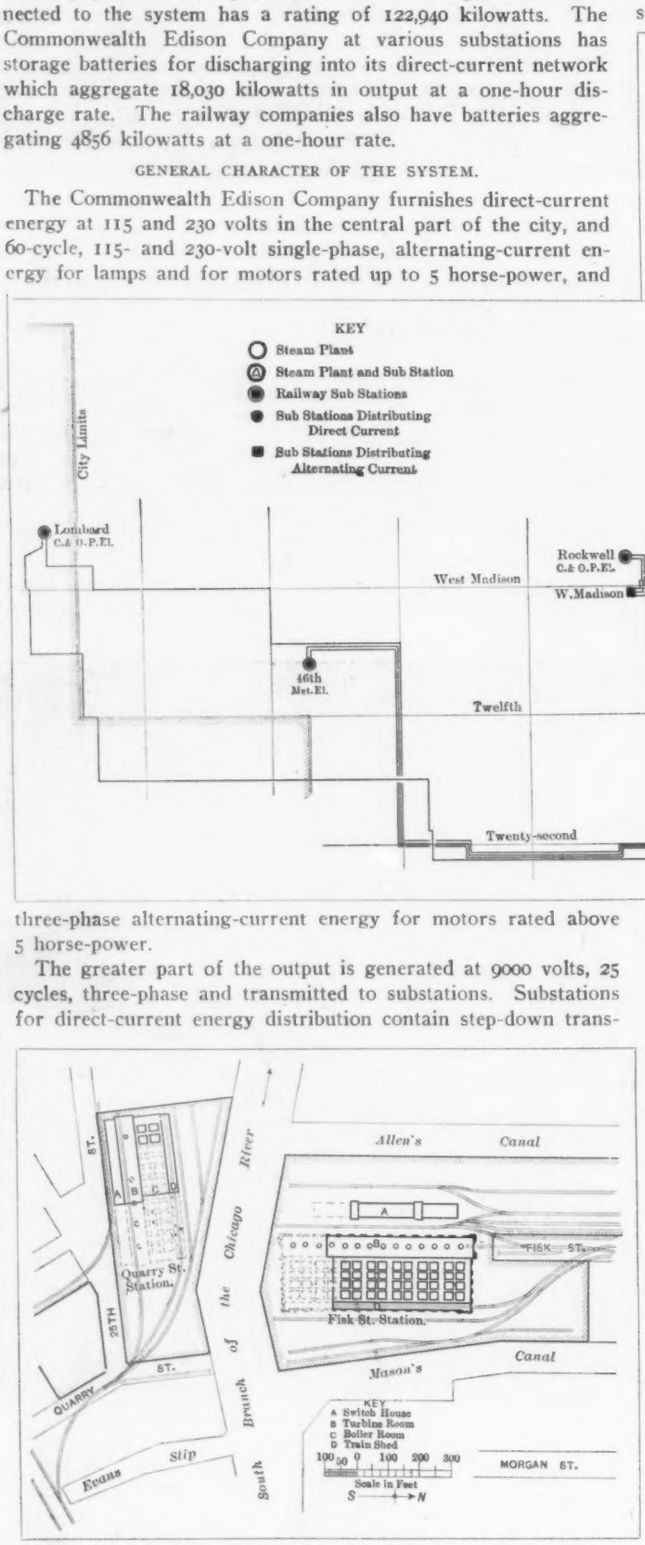


FIG. 3.—COMMONWEALTH EDISON GENERATING STATION PROPERTIES.

Fig. 2 is a map of Chicago, showing the location of the Commonwealth Edison Company's stations and substations and the location of the railway substations with the 9000-volt transmission lines connecting them. The distributing circuits which spread out from each substation are not shown on the map.

FIG. 2.—MAP OF 9000-VOLT, 25-CYCLE TRANSMISSION SYSTEM.

These extend many miles beyond the outlying alternating-current substations.

The direct-current district extends approximately 6.5 miles north and south along the lake and two miles back from the lake. The direct-current network, which was started in the down-town district many years ago, was originally supplied

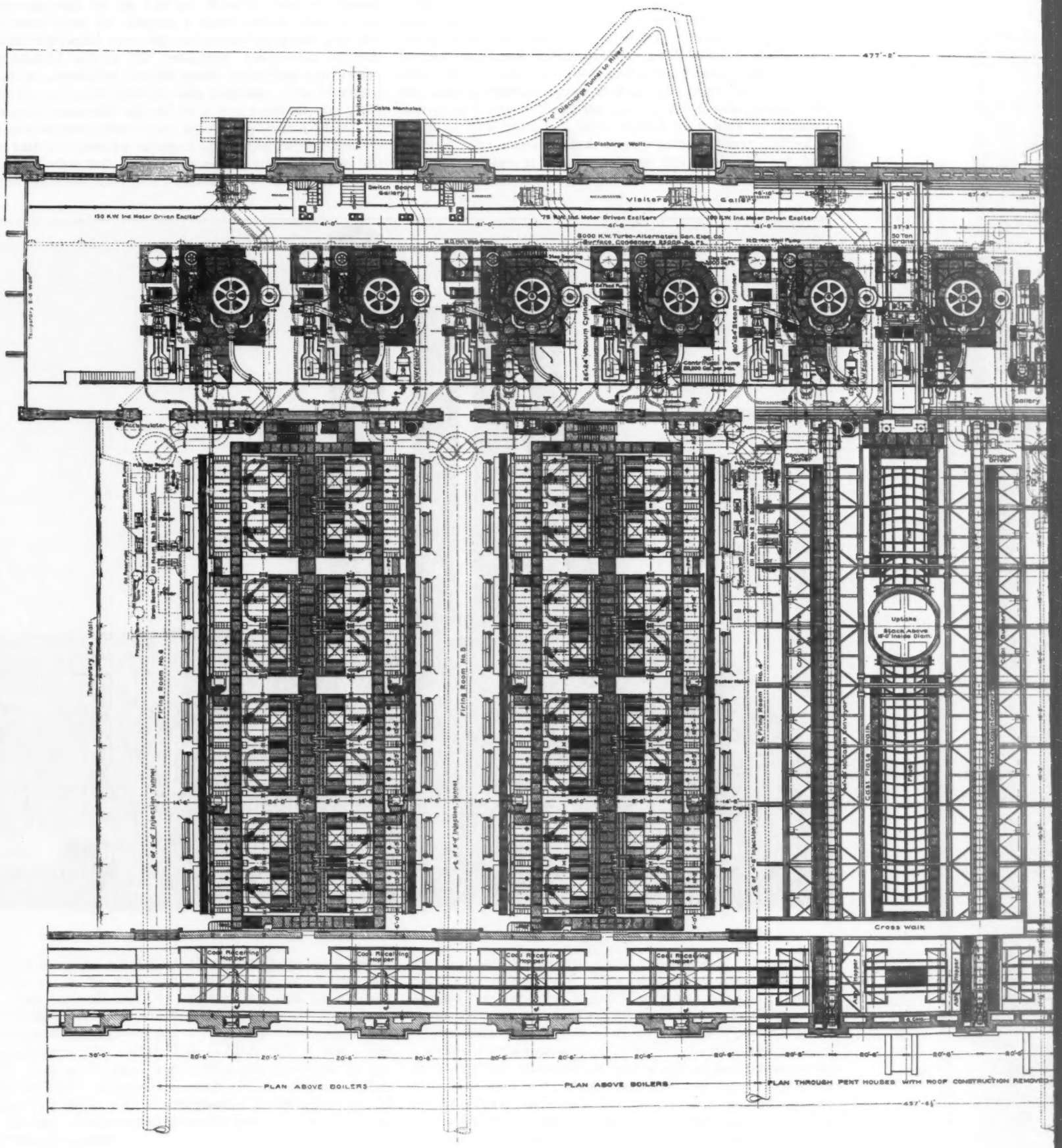


FIG. 4.—GENERAL ARRANGEMENT PLAN OF FISK STREET STATION, SHOWING TURBO-GENERATORS,

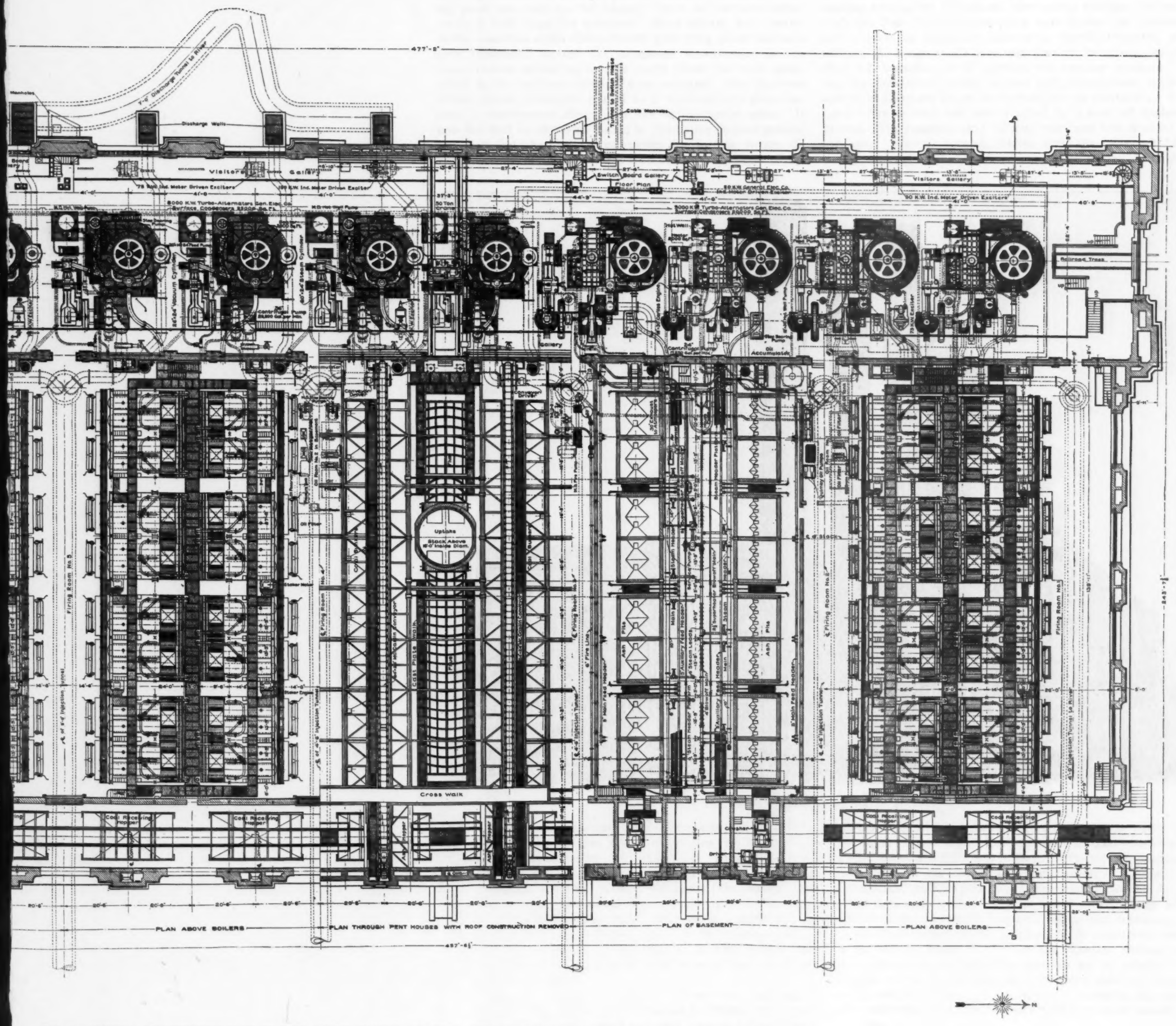
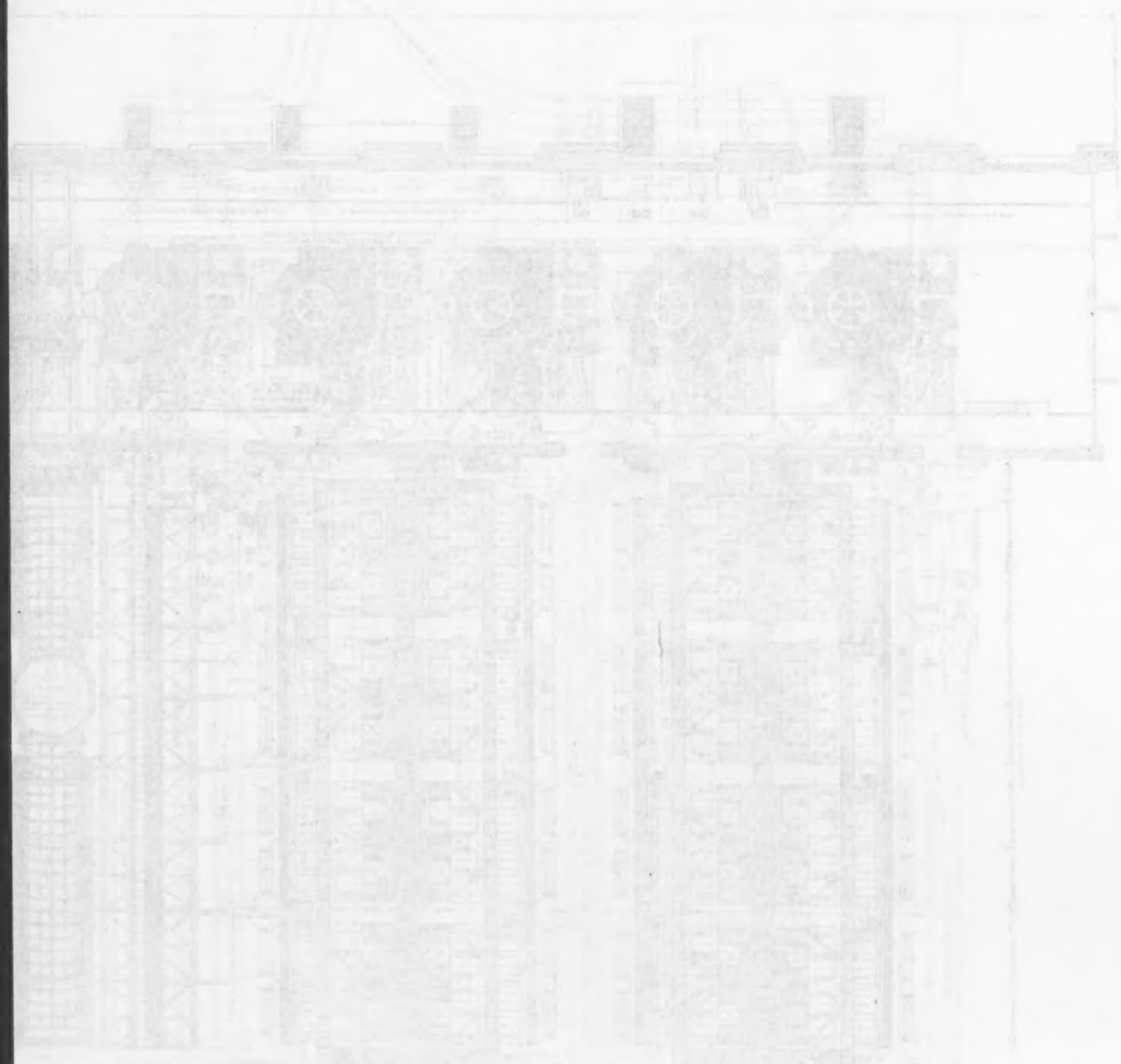


FIG. 4.—GENERAL ARRANGEMENT PLAN OF FISK STREET STATION, SHOWING TURBO-GENERATORS, BOILERS AND COAL-HANDLING EQUIPMENT.



with energy from a small direct-current station in the heart of the business district at 139 Adams Street, where the company's general offices are now located. In 1892 a large generating plant was built on the Chicago River at Harrison Street about .5 mile from the company's direct-current load center. In the meantime small direct-current generating plants had also been established beyond the congested down-town district. Later various alternating-current plants which had been established in the residence districts were acquired. The Harrison Street station, originally started as a direct-current plant, became a combination direct- and alternating-current plant. It now has half its 18,000-kw rating in alternating-current generators and the other half in generators for feeding energy directly into the down-town direct-current network. Some of the latter, however, are provided with alternating-current collector rings so as to give either alternating or direct current. The transmission of energy to substations was first accomplished by double-current generators. The e.m.f. was increased to 4500 volts, three-phase, the energy being transmitted to substations. Later the e.m.f. was doubled, making it 9000 volts, three-phase, which is today the standard transmission e.m.f. of the system. When the great Fisk Street station was planned, in 1901, an e.m.f. of 9000 volts and a frequency of 60 cycles were adopted for all of the turbine generators.

The use of 25-cycle, three-phase current for transmission from a generating station to a substation in Chicago dates back to 1897, when the first rotary converter, one of 250 kilowatts, was put in operation at the Twenty-seventh Street substation with energy supplied from a double-current generator at Harrison Street. A frequency of 25 cycles was selected at that early date because at that time 60-cycle rotary converters were not considered reliable machines because of the difficulties in hunting, getting out of step and commutator troubles. In 1901, when the Fisk Street station plans were drawn, the company had to make an important decision as regards frequency and voltage. A change would have been possible, but it was decided after full consideration to continue the existing standard. It was then generating energy at 9000 volts, three-phase, 25-cycle current at Harrison Street for transmission to substations. The e.m.f. of 9000 volts had been reached by a kind of doubling process. The common e.m.f. of 2250 volts was first doubled to get 4500. Then it became evident that 4500 was not high enough and that a change would have to be made. After that decision transformers were purchased that could be operated at either 4500 or 9000 volts. Thus the e.m.f. of 9000 volts came to be fixed upon, and this, in accordance with common practice, is about right for the distances of transmission in Chicago. As to frequency, the selection of 25 cycles made it possible for the central-station company to offer to sell electrical energy to the electric-railway companies at such a voltage and frequency that it could be used in standard rotary-converter substations erected by the railway companies. If at any time the railway companies wished to generate their own energy, no substation investment would be lost and the generating apparatus used to supply energy to them could be applied to increasing the electric lamp and motor load. In this way neither company would take any risks.

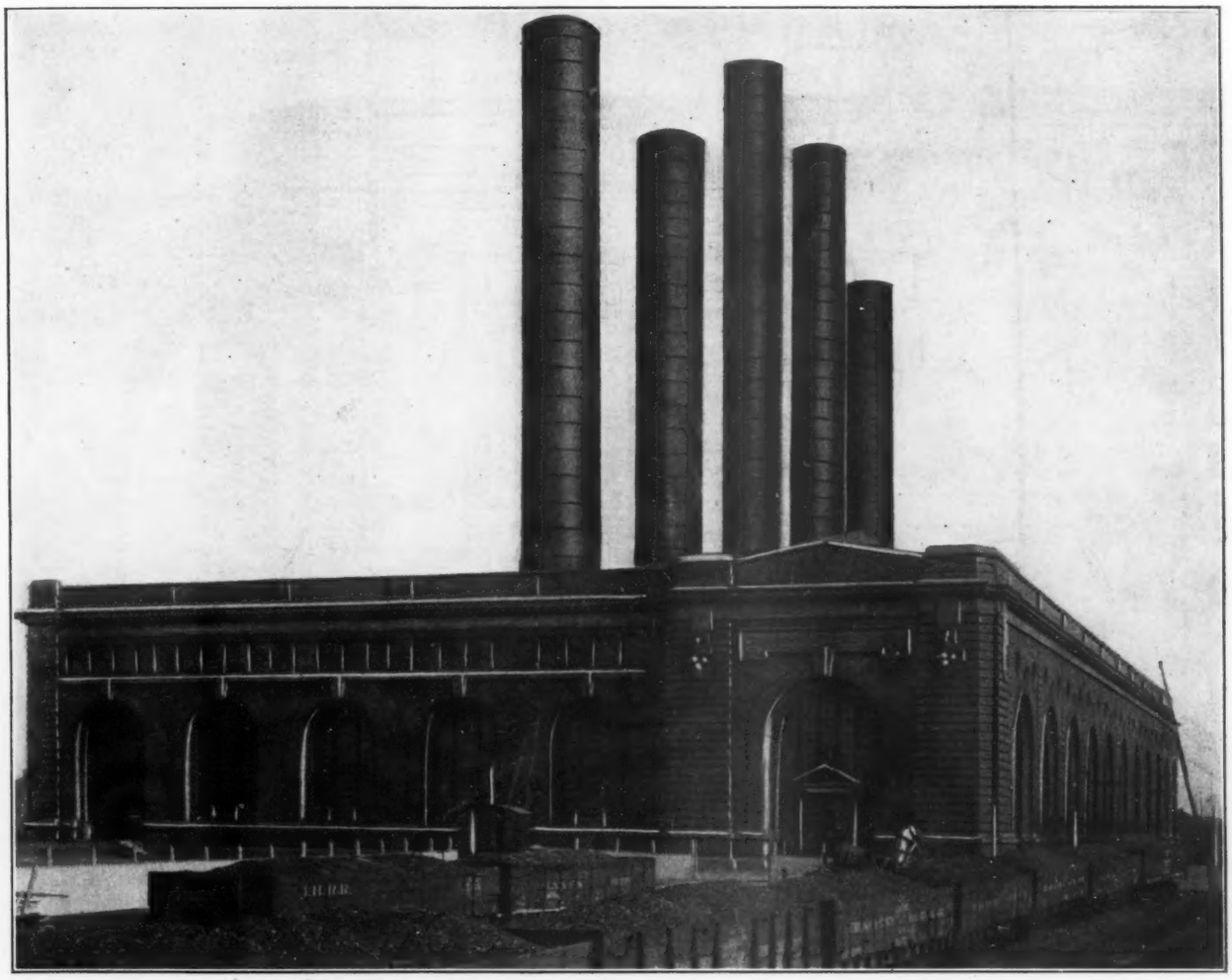


FIG. 5.—EXTERIOR OF FISK STREET STATION.

In the down-town district where the load density is very high, the map indicates that rotary-converter substations re-

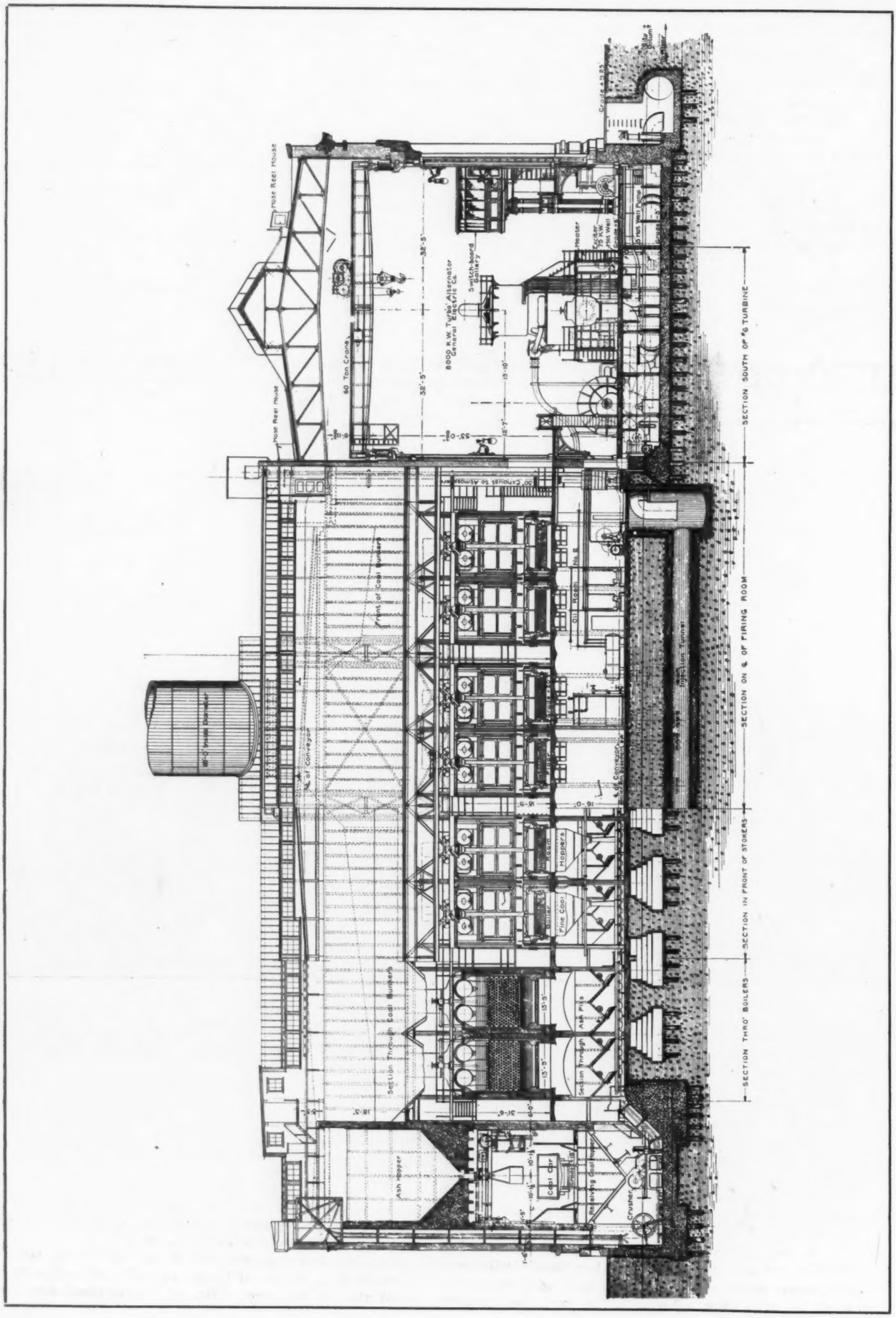


FIG. 6.—CROSS-SECTIONAL ELEVATION OF FISK STREET STATION, CHICAGO COMMONWEALTH EDISON SYSTEM, AT FRONT OF BOILERS.

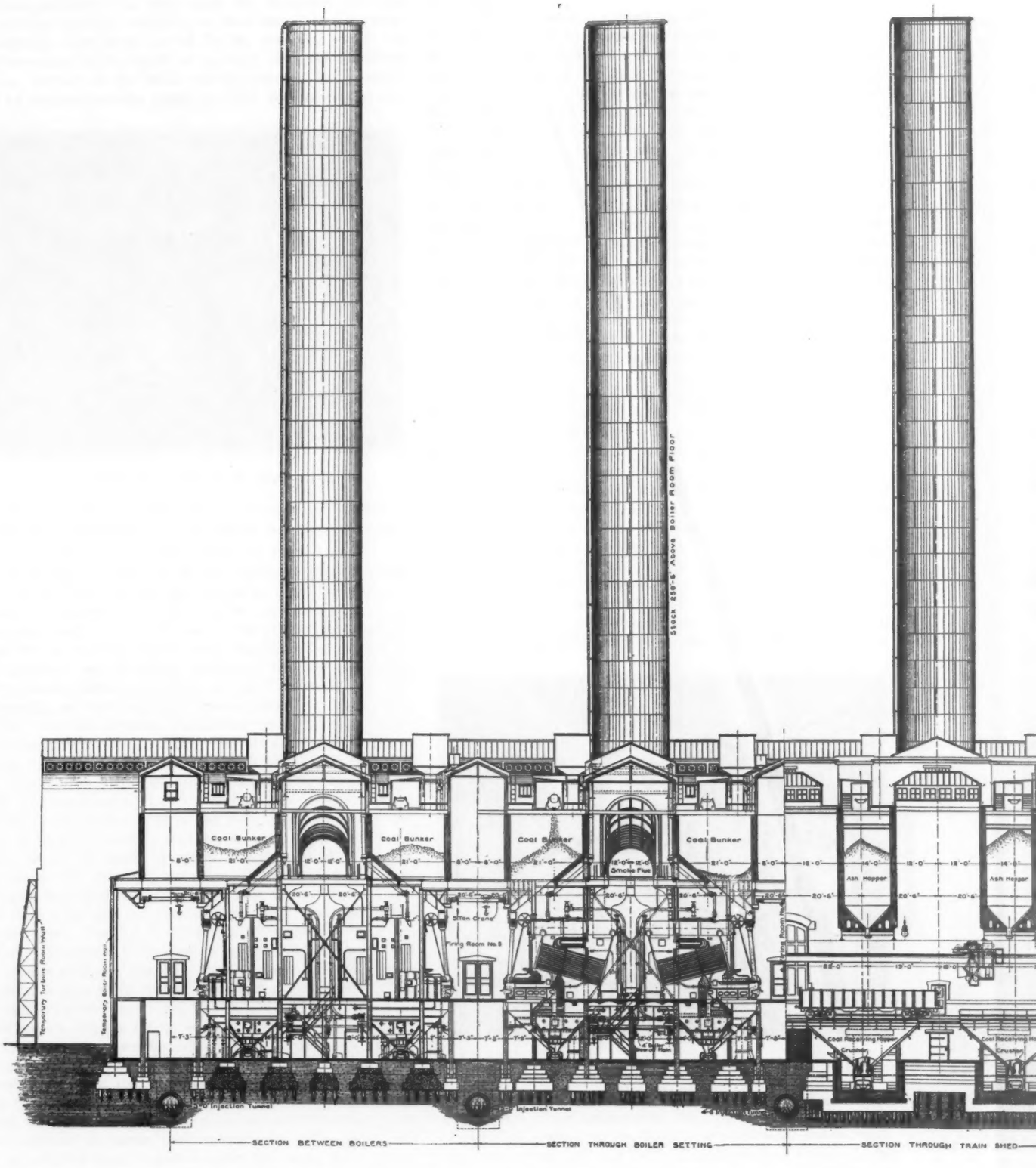


FIG. 7.—LONGITUDINAL SECTIONAL ELEVATION THROUGH BOILER ROOM OF

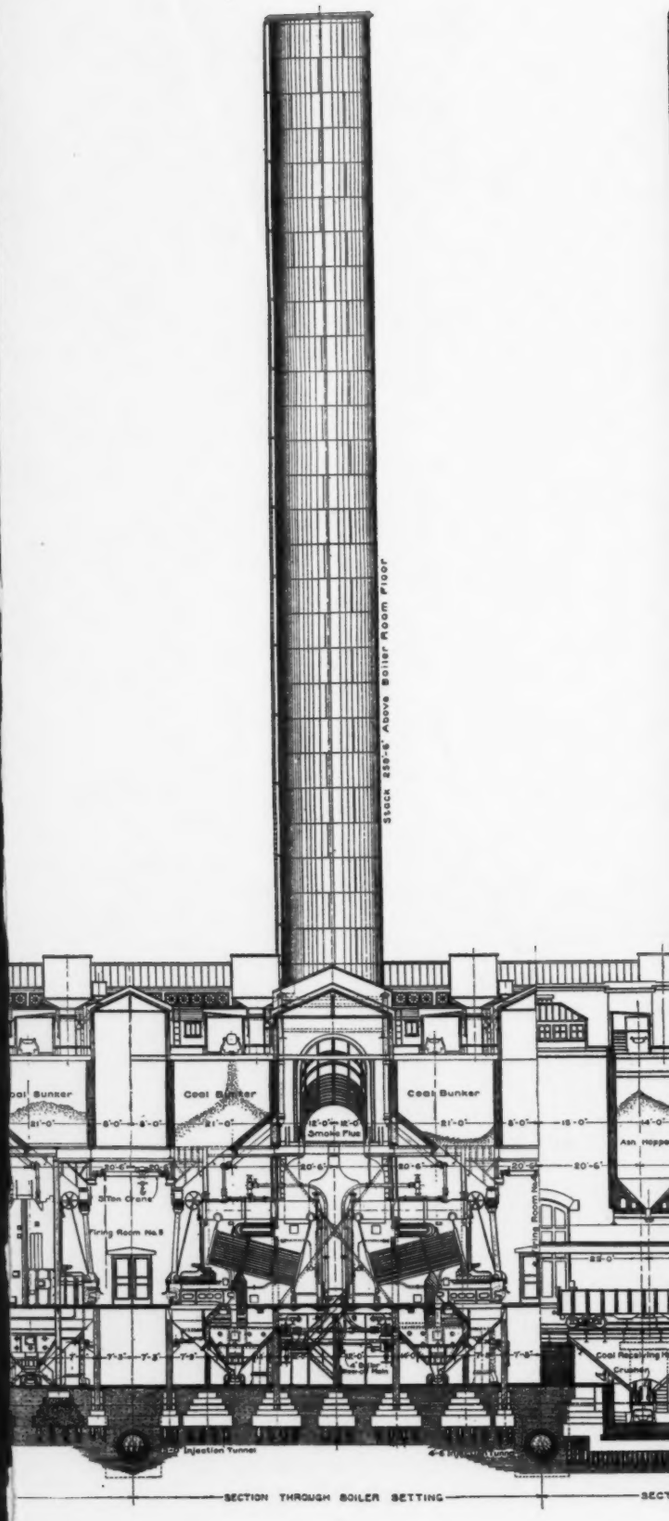
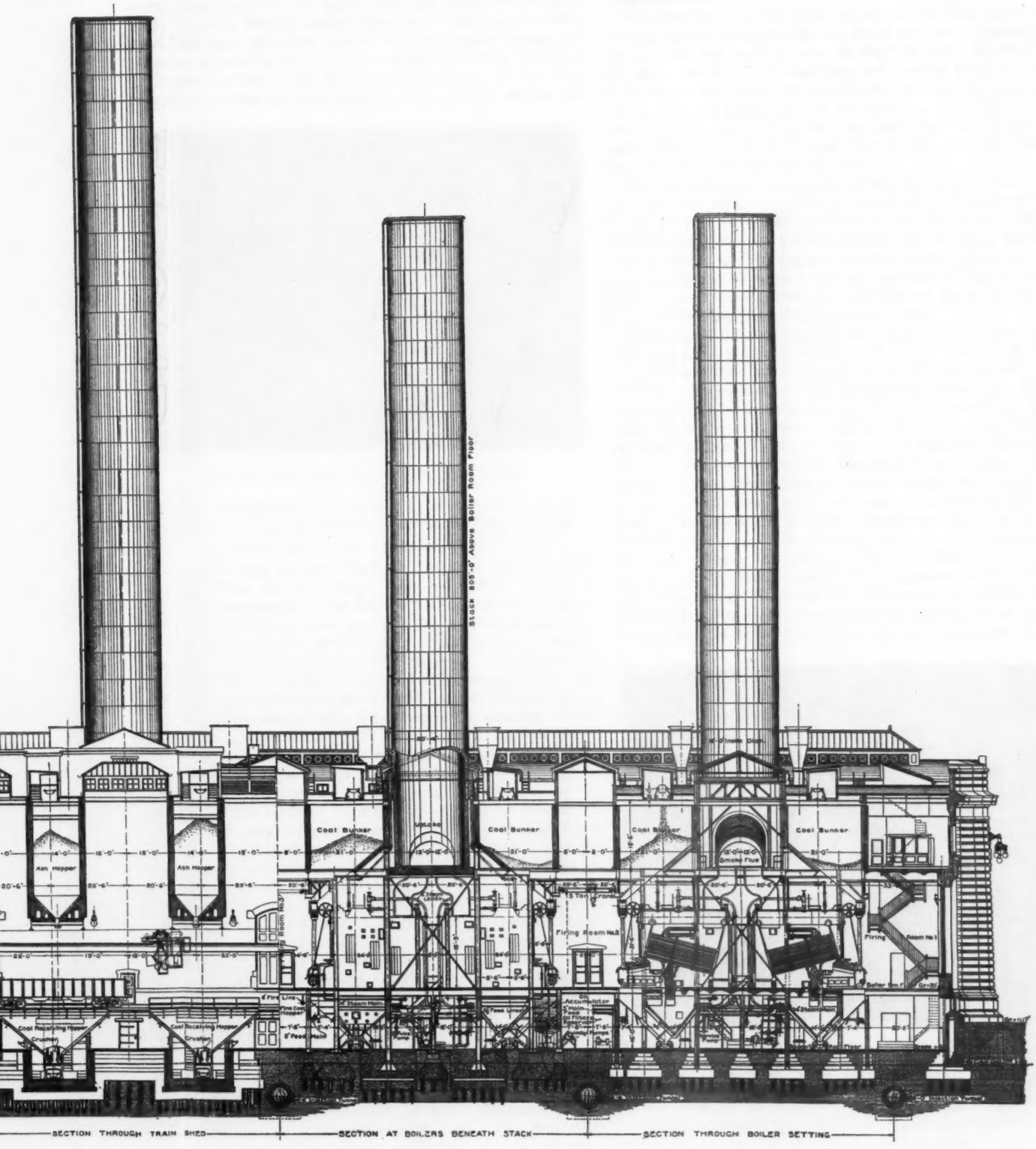
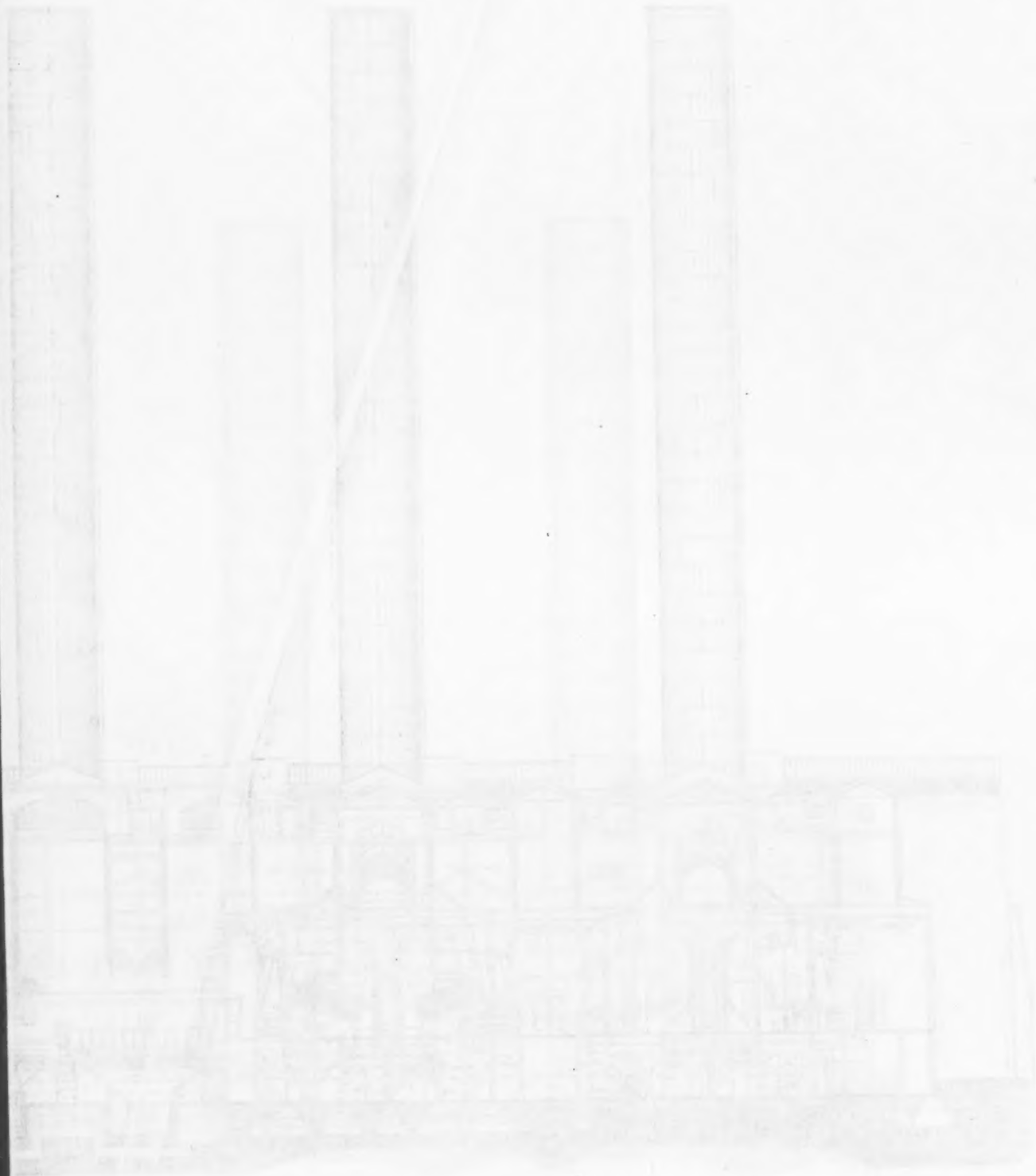


FIG. 7.—LONGITUDINAL SECTIONAL ELEVATION THR



VATION THROUGH BOILER ROOM OF FISK STREET STATION, LOOKING WEST.



ceiving 25-cycle, 9000-volt, three-phase energy have been established at very frequent intervals. These substations for the most part have been established in high-class fireproof buildings, the upper stories of which can be utilized for office and commercial purposes. In some cases the basements of large office buildings already erected have been leased and in other cases buildings have been started by the company which can later be extended to the height of ordinary tall office buildings.

Another feature of the direct-current network is the existence of 15 storage batteries which are kept floating on the line

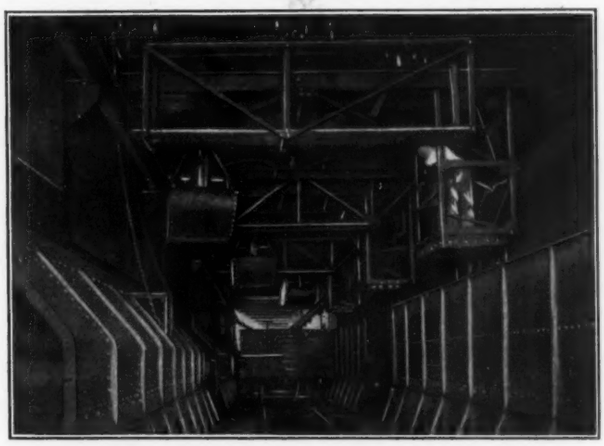


FIG. 8.—UNLOADING BUCKETS IN TRAIN SHED.

purely for emergencies. These are in some cases located in converter substations and in other cases in separate buildings.

FISK AND QUARRY STREET STATIONS.

Five years ago, in 1903, when the National Electric Light Association last met in Chicago, the great Fisk Street station was under construction. The first of the 5000-kw Curtis steam turbine units had not been started. This station as originally planned for 14 5000-kw turbine units, making a total rating of 70,000 kilowatts, was doubtless considered by the majority of engineers, both inside and outside of the Commonwealth Edison Company, as providing for a future growth of many years.

Probably few who attended the convention at that time would have predicted what has actually taken place. The Fisk Street station has been enlarged to carry a peak load of 100,000 kilowatts, although by virtue of increase in size and economy of units it does not occupy all of the ground provided for the enlargement of the station. Across the river from the Fisk Street station, at Quarry Street, a building is being erected to house another station of 84,000 kilowatts ultimate rating. The development is certainly a most remarkable one and brings to mind again the oft-demonstrated fact that the average central-station man is apt to far under-estimate the future possibilities of the business. The Fisk Street station five years ago was an object of much interest as being planned to contain the first 5000-kw Curtis steam turbines, the contract for these turbines having been let at a time when turbine development was in its beginnings in this country and when the building of a vertical-shaft turbine for as large a rating as 5000 kilowatts was a matter involving many unknown factors. Over one-half of the equipment of the Fisk Street station was put in service within the year ending Sept. 22, 1907. Although to the casual observer the station (Fig. 1) appears remarkably uniform in apparatus from one end to the other, as a matter of fact it illustrates an important advance in steam turbine economy. The first units rated at 5000 kilowatts required under test 23.94 lb. of steam per kw-hour, while the last six units of 8000-rated output required only 13.07 lb. of steam per kw-hour.

The Fisk Street station as it stands to-day, and as illustrated in the drawings and photographs which accompany this article, contains 10 turbine units. Of these the first three installed were rated at 5000 kilowatts. For carrying peak load their output may be considered 6250 kilowatts. The third unit installed, rated at 5000 kilowatts, is able to carry 7500 kilowatts during the peak-load period; while each of the last six, rated at 8000 kilowatts, is able to carry 12,000 kilowatts. The total output of the station at peak loads may, therefore, be considered as 98,250 kilowatts.

In connection with the rapid growth of the Fisk Street station the following chronology may be of interest: The contract for the first two turbines was let Dec. 28, 1901. Ground for the first section of the building was broken June 25, 1902. Unit No. 1 was started on commercial load Oct. 2, 1903; unit No. 2, Dec. 11, 1903; unit No. 3, April 21, 1904; unit No. 4, Oct. 27, 1905; unit No. 5, Sept. 19, 1906; unit No. 6, Oct. 10, 1906; unit No. 7, Nov. 13, 1906; No. 8, Jan. 22, 1907; No. 9, July 19, 1907; No. 10, Sept. 22, 1907.

The reason for this remarkable growth is the increase in electric lamp and motor business, combined with the large railway business, which latter now amounts to over half of the 1,000,000 kw-hours generated daily in this station. The company has been able, by virtue of the economy obtained in this station, to offer electrical energy to various railway companies at figures which made it seem to the companies unnecessary to go to the expense of building their own generating plants.

The general arrangement of the power-plant properties at Fisk and Quarry Streets is shown in Fig. 3. Both properties are located on the south branch of the Chicago River. This location, with reference to the distributing system as a whole, has already been shown in Fig. 2. There is a canal or slip on each side of the Fisk Street property. There are also excellent railroad facilities. Coal is brought in by railroad, although in case of emergency it might be brought in over the river. Condensing water is taken from the slip on the upstream side of the station through tunnels which pass under the station to the condensers, and discharge into the downstream slip. As is evident from the plan of the property (Fig. 3) there is abundant yard room around this station. This is utilized for the storage of coal. A switch engine is kept constantly in use shifting cars. The present daily coal consumption of the plant is about 40 carloads. For coal-storage purposes a good grade of washed coal is used in order that there may be a minimum loss in

FIG. 9.—CIRCULATING WATER PUMPS, FISK STREET STATION.

storage. As can be seen from the dotted lines in Fig. 3, there is still room for enlargement of the Fisk Street station.

Instead of completing the Fisk Street station at present to its final size, it was decided best to start another station across the river at Quarry Street, as shown on Fig. 3. The reason for starting the separate station was mainly to avoid having the entire generating equipment in one station, which might by some remote possibility become partially disabled.

The general arrangement plan of the Fisk Street station is shown both on the map of the property (Fig. 3) and in the detailed plan of the station (Fig. 4). Longitudinal and cross-

sectional elevations are shown in Figs. 6 and 7. The row of turbines in the turbine room extends north and south and opposite each turbine unit at right-angles to it, extending east and west, is a battery of boilers of sufficient size to supply steam to that unit. The "comb" arrangement of apparatus, made possible by the fact that there were no real estate limitations, is a very desirable one in many respects, and makes a simple arrangement with all the boilers supplying steam to a single turbine unit on one floor in two straight lines. This plan simplifies the conveying and storage arrangements, and the piping is also not complicated.

Coal is received in the train shed at one side of the boiler room. If it is in dump cars it is simply delivered into hoppers, from which it is taken by conveyors to coal bunkers over the boilers, as shown in Fig. 7.

When dump cars are not obtainable (which is true with most of the coal delivered to the station) electrically-operated grab buckets, as shown in Fig. 8, are used to do most of the unloading. In this case it is, of course, necessary for laborers to clean out the corners of the cars. Each row of boilers has its conveyors, the same set of conveyors serving for both coal and ashes.

The bunkers in this station can hold a total of 10,800 long tons. Each conveyor can handle 75 tons per hour, the conveyor serving only one turbine unit. The station uses about 1500 long tons per day.

For each turbine unit there are eight B. & W. water-tube boilers, with B. & W. chain-grate stokers, each boiler having a heating surface of 5087 sq. ft. The usual rating of such boilers, 10 sq. ft. per horse-power, gives a nominal rating of about 4100 horse-power for each bank of boilers. This rating, however, is largely of academic interest in connection with this station, where the rates of working the boilers and the economy of the turbines make it possible for a bank of these boilers to supply steam to turbines of 8000-kw rated output working sometimes at 12,000 kilowatts. The grate areas on boilers supplying steam to units 1 to 3 is 76.5 sq. ft, for a heating surface of 5087 sq. ft. On unit No. 4 the boilers have a grate area of 8325 sq. ft. On units 5 to 10, which have a rated output of 8000 kilowatts, the boilers have 90 sq. ft. of grate surface. These boilers are, therefore, worked at a very high rate of steaming. The steam pressure is 200 lb. per square inch. The boilers have superheaters of 900 sq. ft. surface and the superheat temperature used is 150 deg.

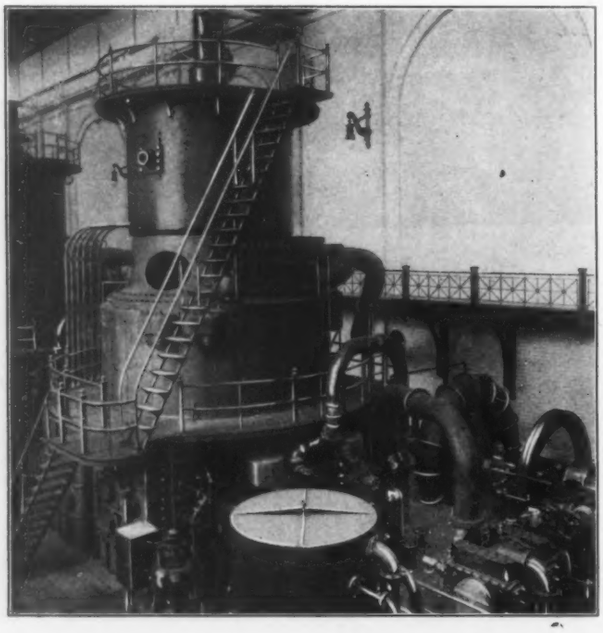


FIG. 10.—8000-KW TURBINE AND AUXILIARIES.

Turbine performance having been brought to a high state of efficiency, boiler-room economies are being strictly looked after. Boilers have been tested under very high rates of combustion with boilers giving from 150 to 200 per cent of their rated output. The best economies seem to be obtained under these conditions, the flue gas temperature being only a little higher than at lower rates of working.

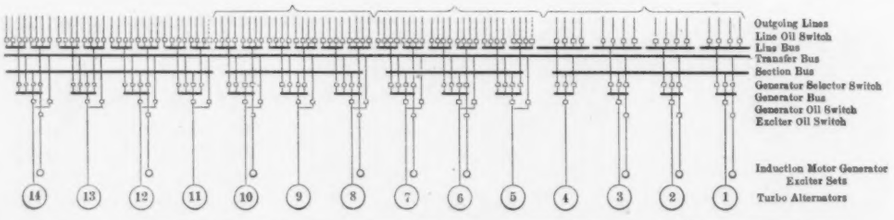


FIG. 11.—GENERAL SCHEME OF HIGH-TENSION CONNECTIONS AT FISK STREET STATION.

The coal used in this station is obtained from central Illinois; it averages from 15 to 20 per cent in ash, and from 13 to 29 per cent in volatile matter. The average b.t.u. per pound of coal is 10,430.

In the regular operation of the Fisk Street station, the aim is to vary the number of turbine units in operation from time to time so as to have each machine run as nearly as possible to its rated load. Boilers not in use, but to be called for at some hour of the day, are kept under pressure with fires banked.

The latest and most efficient units are, of course, operated as much of the time as possible, the first units installed being used only for peak load. The coal actually used by the station during 24 hours averages about 3.33 lb. of Illinois screenings per kw-hour.

The steam-pipe line from each row of boilers connects to one turbine. Cross-connections are provided so that these boiler-unit rows can be connected in pairs, but pairs cannot be connected together. In this way the station is completely sectionalized so that trouble on the pipe lines of one unit cannot spread to others.

There is one stack for each two boiler and turbine units. Three of the stacks are 256 ft. high and 18 ft. 10 in. inside diameter. The other two stacks are 200 ft. high.

As regards the oil pumping for step bearings, each pair of units has a pair of duplicate pumps, an accumulator and a storage tank. When the accumulator falls below a certain point a motor-driven step-bearing oil pump is automatically started. One of these step-bearing pumps is shown in Fig. 9.

The last five turbines installed, of 8000-kw rated output, with ability to work at 12,000 kilowatts during peak load, are Curtis five-stage machines running at 750 r.p.m. One is shown in Fig. 10, together with its auxiliaries. These turbines stand 34 ft. 8 in. above the floor. The governors are of the hydraulic type. The Worthington surface condensers, which are located in the base of each unit, have 25,000 sq. ft. of tube surface and can handle 216,000 lb. of water per hour. Each unit has its own condensing apparatus, feed-water heater, hot wells and feed pumps. A centrifugal hot-well pump, seen in Figs. 9 and 10, takes the condensed steam from the condenser and delivers it to the feed-water heater. This centrifugal pump is a 4-in. vertical-shaft, two-stage machine driven by a 20-hp direct-current motor, seen in Fig. 10. The dry-vacuum pump and the centrifugal pump for circulating the condensing water are driven by a Corliss engine running at 75 r.p.m. The circulating pump is of Worthington make for handling 22,500 gal. per minute. Each unit has two vertical uniplex feed pumps 20-in x 14-in. x 24-in. made by Deane Brothers, with a rating of 581 gal. per minute. The closed feed-water heater has 3000 sq. ft. of surface, with ability to raise the temperature of 160,000 lb. of water per hour by 55 deg.

The floor area per turbine in this turbine room, including all the auxiliaries, is 273 sq. ft. The turbine room has two traveling cranes of 70-ft. span, one being a 50-ton Whiting and the other a 60-ton Niles.

The general scheme of high-tension connections in the Fisk Street station is shown in Fig. 11, as designed for the completed station with 14 units. Only 10 units have so far been installed. The sectionalizing busbars and the possible isolation of different parts of the station electrically to prevent spread of trouble is always a matter of considerable interest and concern in connection with a large plant of this kind. It will be seen from Fig. 11 that the first four units installed, which are of smaller rating than the last six, have a different scheme of connections. The first four units are connected through an oil switch to a short bus called a "generator bus." To this "generator bus" three oil switches are connected, one of which joins it with a section bus; the second with a "transfer bus" which extends through the whole station, and the third to a "line bus" which is really a kind of sectionalized feeder bus to which the oil switches of the outgoing feeders are connected. Each of these line buses supplies energy to four feeders. It is evident that these feeders can receive energy either directly from a generator, or from a section bus, or from some other section through the transfer bus.

For generators 5 to 10 there is a different arrangement. Each generator is provided with two oil switches, one of which may connect it directly to the transfer bus. The other switch connects it to its generator bus. To the generator bus four outgoing oil switches are joined. From the generator bus two of these oil switches unite it to two sectional line buses, a third connects it to the section bus, and a fourth to the transfer bus.

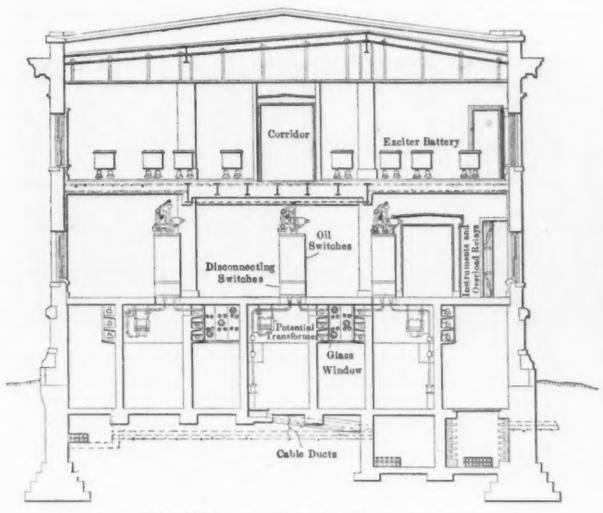


FIG. 12.—SECTIONAL ELEVATION OF OIL-SWITCH HOUSE.

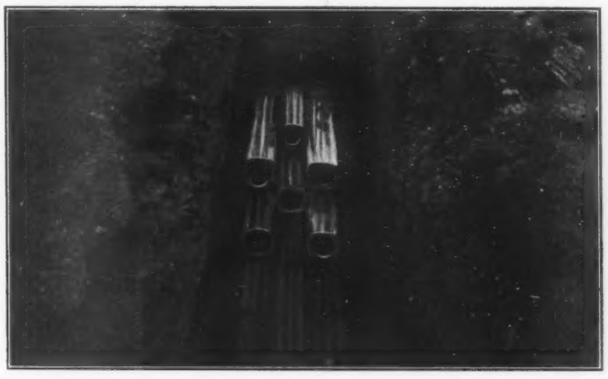


FIG. 14.—TYPICAL CONDUIT CONSTRUCTION.

The motor-driven oil-generator switches are operated from a remote-control board on a gallery of the turbine room. Feeder switching and metering are done in the switch house adjoining the station. A cross-sectional elevation of this switch house is shown in Fig. 12. All the busbars, oil switches and meters, as well as the principal operating switchboard, are placed in this switch house. On the first floor are busbar compartments and instrument transformers. On the second floor are the oil switches and the overload relays, instruments and switchboard. To aid in avoiding mistakes the mosaic floor of the switch room has in white lines a diagram indicating the busbar relations of the circuit leading to each oil switch. It is, therefore, unnecessary for employees to enter the busbar compartment rooms in order to trace the circuits.

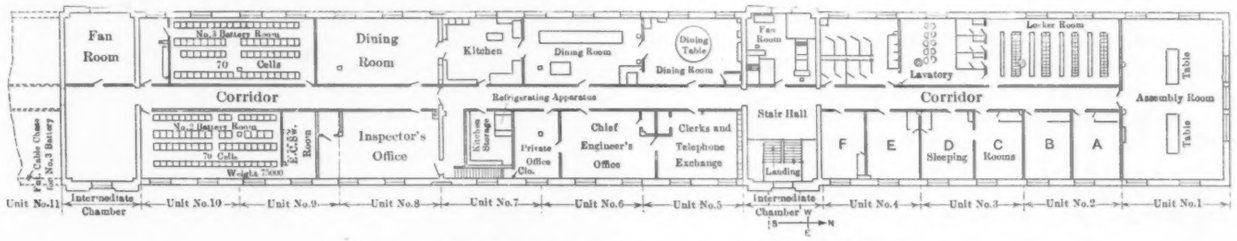


FIG. 13.—WELFARE ROOMS AT THE FISK STREET STATION.

FIG. 15.—OCTAGONAL MANHOLE AND APPROACHES.

FIG. 16.—CABLE PROTECTION AT MANHOLES.

On the top floor of the switch house is the exciter battery and employees' rooms, mentioned later.

The relays which open the oil switches under an overload

are of the bellows type in which the rate of opening is dependent on the expulsion of air from a little bellows due to the magnetic pull of the relay, and hence is more rapid the severer the short-circuit current.

The switchboards are arranged with busbar diagrams on their faces, and handles are so placed as to indicate just what the connections are when the switches are thrown.

About half the output of the Fisk Street station is sold wholesale by watt-hour meter measurement at the generating station busbars to various street and elevated railway companies. The rate made to the railway companies on this class of business is an indication of the economies attained in generation at Fisk Street, as the Commonwealth Edison Company must, of course, estimate on the highest economy and a very small margin of profit to be able to hold this railway business in competition with possible generating plants to be built by the railway companies themselves. This rate consists of a kind of readiness-to-serve charge based on the maximum demand made by a railway company during any one hour of the year, plus ½ cent per kw-hour. This ½ cent per kw-hour, of course, covers only the operating costs. The fixed and investment charges are supposed to be taken care of by the readiness-to-serve charge, which is $15 per year per kilowatt of maximum demand. The maximum demand in kilowatts is taken as equal to the largest number of kw-hours delivered to a railway company during any one-hour period of the year.

As the measuring of this wholesale energy involves such large amounts of money, considerable study has been given to the methods of measuring and the accuracy of instruments. At first it was the practice to have the switchboard attendant read each railway watt-hour meter on the Fisk Street switchboard once each hour. This method was objectionable because of the possible errors involved by not reading the meter exactly at the specified time. If such an error occurred during one of the heaviest-load periods of the year, a great difference would be made in the fixed or readiness-to-serve charge paid by the railway company. An instrument was then applied to the watt-hour meter whereby the position of the dial pointers was punched in a sheet of paper once each hour. Then by putting this sheet of paper over a dummy dial the position of the pointers at the time the punching occurred could be instantly determined. A further refinement has been evolved from this, however, and now the hourly readings of the watt-hour meter are recorded in numerals on a sheet of paper.

Transmission lines of 9000-volt, three-phase cable leave the Fisk Street station by six different routes north and two south;

FIG. 17.—EXTERIOR OF SUBSTATION.

the two south going under the river in a tunnel. The separation of these conduit lines is a matter of great importance when dealing with such enormous outputs. A heavy short-circuit current on any one line of ducts has been demonstrated to be capable of fusing ducts, cable, sheaths and conductors into one conglomerate mass for 100 or more feet of duct without causing enough disturbance to be noticed or to trip the overload relays.

The amount of labor required in the operation of a mammoth generating station of this kind is a matter of interest. The number of men actually in attendance on the machinery in operation is surprisingly small. The number of men employed on general work, however, increases the total number to over 300, including all working "shifts." The work is divided in eight-hour shifts. A proper conception of the labor factor can

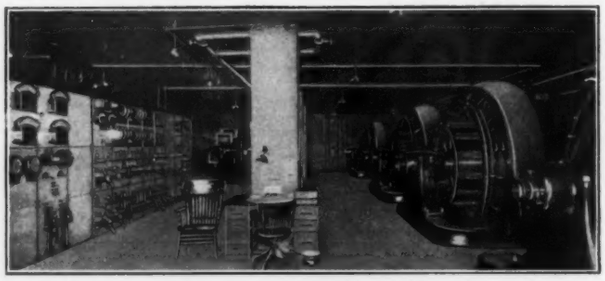


FIG. 18.—SUBSTATION IN BASEMENT OF OFFICE BUILDING.

best be obtained by considering the number of men required per unit, a unit representing from 8000 to 12,000 kilowatts in the latest units installed. The list of operating men per unit is shown in the table.

Moreover, there is a general force for the station consisting of the following men: Chief engineer, first assistant engineer, second assistant engineer, chief electrician, assistant electrician, second assistant electrician, boiler-room foreman, fuel engineer. Besides these there are steamfitters, machinists, machinists' helpers, watchmen and janitors, all under their respective foremen, their number being varied from time to time.

The provisions for the comfort and welfare of employees around the Fisk Street station are even more notable than the engineering features of the station. In providing these comforts the management has realized that to get and keep the

OPERATING MEN PER UNIT.

In turbine room, including janitor work	2
In oil room	1
Attending water	.5
Fireman	1
Fireman's helper	1
Conveyor men	2
Turbine switchboard gallery	.3
Exciter tenders	.2
Switch-house attendants	.17

highest grade of faithful employees provisions for the comfort and welfare of these employees are important. This is even more necessary at the Fisk Street station than it would be in some other locations, because the station is in a district surrounded by railroad yards, factories, lumber yards and a poor class of dwellings, so that restaurant and other facilities for the men are not to be found in the neighborhood. In providing these comforts the station employees are divided according to occupation. Beginning at the bottom, the coal heavers employed in unloading cars have washing and toilet facilities in the basement of the boiler room which are far superior to those usually provided for this class of labor. The boiler-room men are provided with toilet and bath facilities in the north end of the boiler room. Here both shower and tub baths are installed. The turbine-room and electrical men have quarters on the top floor of the switch house. The plan of this floor is shown in Fig. 13. This floor contains offices for the chief engineer and clerks, the kitchen and several dining rooms, where meals are served somewhat below cost. All working "shifts" are served here. Sleeping rooms are provided for use in case of emergency work. Across one end of this floor is a large assembly room and library. The Fisk Street station, therefore, offers almost the facilities of a club for its occupants, and in emergencies men can live there in comfort for days at a time.

The new Quarry Street station, as will be seen from Fig. 3, is to be entirely different in its general plan from the Fisk Street station. This is because of the real estate limitations at Quarry Street. In the Quarry Street station the boilers are in two rows parallel with the turbine room, and the firing space is also parallel with the turbine room instead of being at right-

angles to the turbine room as at Fisk Street. The turbine space for each unit is, therefore, longer and narrower than at Fisk Street.

The Quarry Street station building will contain three turbine units having a total of half the ultimate rating of the station. These turbine units are to be 14,000-kw machines. The steam-turbine part of these units will be the same in size as on the largest Fisk Street units. The generator part of the unit will be larger, however. The experience at Fisk Street has demonstrated that the rise in temperature in a turbo-alternator under load takes place much more rapidly than in large slow-speed engine-driven units. Consequently, there is not so much difference between the temporary overload that a turbo-alternator can safely carry and the load which it can carry continuously, as there is in the temporary overload and continuous permissible load of large slow-speed units. The reason for this, of course, is that the body of copper and iron is larger in proportion to the heat losses to be dissipated in the slow-speed unit than in the high-speed turbine.

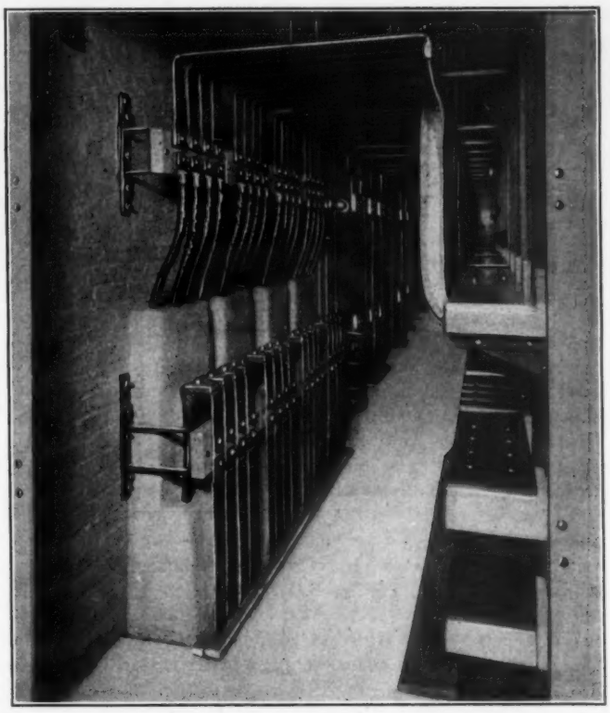


FIG. 19.—HORIZONTAL BUSBARS OF DIRECT-CURRENT FEEDER BOARD.

The temporary overload rating of the turbo-alternator is, therefore, not far from its rating for steady load.

In the Quarry Street generators a novel provision for ventilation is to be made. Air ducts under the turbine room are to be connected to an outside air intake. From these ducts a large pipe will take air up to the top of the generator. The rotor or field cores of the generator will be provided with a fan, which will draw air from the duct down through the generator windings and discharge it into the turbine room below the generator in the space between the generator and the steam turbine.

There are to be eight boilers, each having 5087 sq. ft. of heating surface, for each 14,000-kw unit, this being the same boiler-heating surface that is provided for each unit in the Fisk Street station. It is thus interesting to note that although the kilowatt rating of the turbine units has been raised to almost double those of the first units in the Fisk Street station, the boiler heating surface has not been altered. However, the grate surface and the draft have been increased. The Quarry Street station boilers are to have 110 sq. ft. of grate surface per boiler, as against 90 sq. ft. in the latest boilers at Fisk Street and 76.5 sq. ft. in the first boilers at Fisk Street.

The arrangement of boilers with reference to the furnaces at Quarry Street is radically different from that at Fisk Street At Quarry Street the position of the B. & W. boilers with reference to the chain-grate stokers will be practically reversed from common practice; that is, the water tubes will slant toward the furnace. The furnace gases will pass a considerable distance from the grate before striking directly any water-tube surface. The furnace proper for some distance is, therefore, entirely surrounded with firebrick so as to maintain the high temperature conducive to good and smokeless combustion. After leaving this combustion chamber proper, the gases pass up through the rear ends of the water tubes to the level of the superheaters and lower part of the steam drums. They then make one downward passage to a point over the rear of the furnace and then an upward passage to the stack.

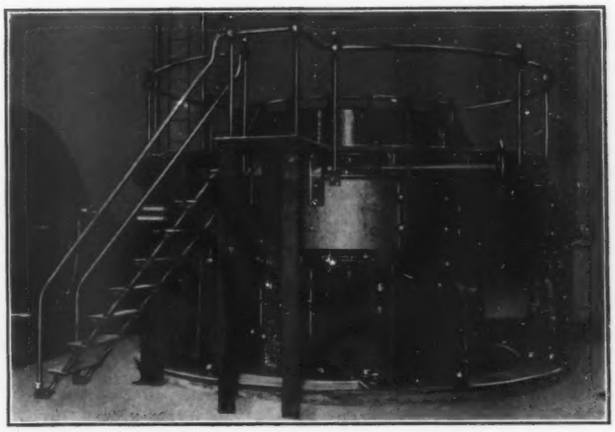


FIG. 20.—VERTICAL-SHAFT ROTARY CONVERTER.

The condensers will be placed in the base of the turbines, although one-third of the condenser will extend outside of the turbine base on account of the amount of condensing surface necessary. Condensed steam will be taken out of the condensers by a centrifugal hot-well pump driven by a Kerr steam turbine. A dry-vacuum pump and a centrifugal pump for circulating water will be driven by a Corliss engine. Each pair of turbines will have three horizontal boiler feed pumps. The oil step-bearing pumps and accumulators are independent for each turbine. Each turbine has two steam-driven oil step-bearing pumps and one hydraulic accumulator.

Three provisions will be made for supplying exciting current to the generators. For each pair of units there will be one 50-kw steam turbine. A storage battery located in the switch house can also furnish exciting current. There will be a substation with a 250-volt rotary converter for supplying direct-current locally in the station and vicinity. The wiring will be such that this also might be used for supplying excitation current. The rotary converter to be used in this substation will be a 500-kw machine and will be the first of the Woodbridge split-pole design to be used in Chicago. With this converter

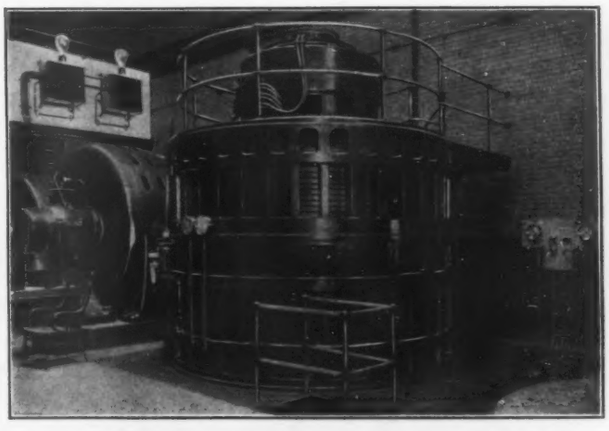


FIG. 21.—VERTICAL-SHAFT MOTOR-GENERATOR.

voltage regulation is accomplished in the machine itself without recourse to induction regulators in the alternating-current supply lines.

CABLES AND DUCTS.

The standard high-tension, 9000-volt, three-phase underground feeder cable used for transmitting energy from generating plants to substations is one having three No. 4-0 conductors each with 6/32-in. paper insulation and 4/32-in. paper insulation over all three. The lead covering is ⅛ in. For the 20,000-volt underground transmission system, of which there is one 11-mile line at present, a three-conductor cable having three No. 2-0 conductors is used, the insulation over each being 9/32 in. paper, with 6/32-in. paper over all.

For the 60-cycle feeders, which operate at 4000 volts, three-phase, four-wire, a four-conductor No. 0 cable is used. Single-conductor No. 0 cables are also used on the 60-cycle distributing system. The insulation of these cables is 5/32-in. paper over each conductor and 3/32-in. over all conductors. For the single-conductor cable the paper is 10/32-in. thick.

The standard construction for high-tension cable ducts is shown in Fig. 14, illustrating a conduit line under construction. Single-duct tile is used with a 3½-in. hole and with ⅞-in. wall. The joints are staggered, both for mechanical strength and to prevent the spreading from one duct to another of trouble due to the escape of hot gases created by an arc through joints from one duct to another. When the ducts approach a manhole they are gradually spread out so as not to enter the manhole in a bunch. This arrangement is illustrated in Fig. 15. The manholes are made octagonal in shape. The object in keeping ducts as far apart as possible where they enter the manhole is to facilitate the work of running cables neatly through the manhole. At manholes the cables are not left exposed as in the old practice, but they are carefully and completely covered with split-tile duct, as indicated in Fig. 16, so as to isolate each cable as much as possible. The idea of this is, of course, to prevent the spread of short-circuiting trouble in manholes.

The art of cable-joint making has become so perfect in this company that joint failures are almost unknown. Minerallac compound and tape are used in these joints, these products having originated with engineers of this company.

SUBSTATIONS.

The substation buildings are of the highest class of construction. Fig. 17 shows the exterior of the West Twenty-second Street substation, which is in a locality near the Fisk Street station, where real estate is relatively cheap. In districts where land is more valuable the company employs as a substation the basement and first floor of a building, the upper floors of which can be used for office or other purposes. In the most congested down-town districts the practice has been to obtain a long lease of basement space in high-class fireproof office buildings. The interior of such an office building substation located in the basement of the Railway Exchange Building is shown in Fig. 18.

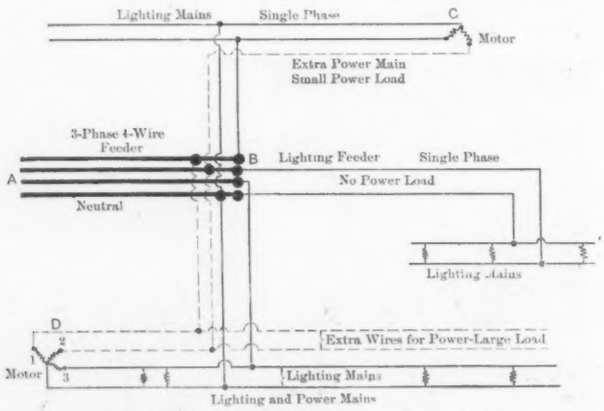


FIG. 22.—ALTERNATING-CURRENT DISTRIBUTING CIRCUITS FOR LAMPS AND MOTORS.

In a typical substation the 9000-volt transmission lines from the generating plants enter through either motor-operated or solenoid-operated oil switches which connect them to the substation busbars. From the busbars the various rotary converter or motor-generator units are operated. In case of a direct-current substation, a rotary-converter unit and its equipment, there is a motor-operated or solenoid-operated oil switch with overload relays which controls the supply of high-tension alternating-current energy to the unit. From this oil switch the 9000-volt energy is taken to a three-phase step-down transformer, which reduces the e.m.f to 186 volts. Three-phase transformers rather than three single-phase transformers have been regularly used with this company since 1902, when the first transformer of this kind was ordered. Each unit occupies less floor area than three separate transformers. The transformer secondaries are connected six-phase and pass directly to the collector rings of the rotary converter through a motor-operated induction regulator. This regulator can be moved to raise or lower the direct-current voltage by a motor-controlled circuit terminating at the switchboard. The direct-current leads from the rotary converter, according to the latest practice with large machines, are not joined to the generator switchboard, but are connected and disconnected by a solenoid-operated switch, and only the control circuits are taken to the board. The neutral point of the converter is connected to the neutral of the direct-current three-wire system so that balancer sets are not ordinarily required. In each substation where there is a storage battery, the latest practice is to provide the transformers for one rotary converter with extra high-voltage taps so that an e.m.f. high enough to charge storage batteries can be obtained from that converter, so that a booster set for battery charging is not needed. The generator leads pass directly by the shortest possible route to busbars, from which feeder switches connect to the various feeders. In substations feeding energy over long distances three separate feeder busbars are installed to make it possible to deliver three different voltages. In certain of the substations feeding energy over short distances only two sets of busbars, however, are provided.

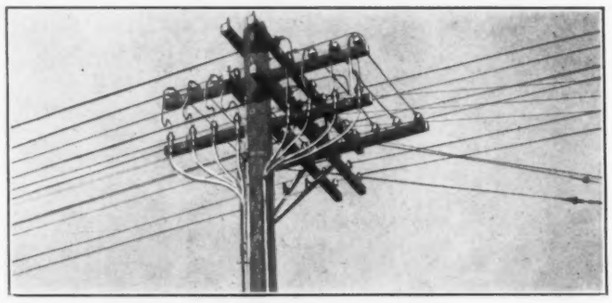


FIG. 23.—CABLE POTHEADS.

Fig. 19 illustrates typical busbar practice of this company, the special feature of which is that busbars are placed horizontal, which makes work about the switchboard easier. It will be noticed that the feeder fuses are located on the wall back of the switchboard, beyond which feeders immediately pass into tile ducts. These feeders are confined in ducts, not being again exposed until they reach the consumer's premises. Rotary converters are started from the direct-current end, sufficient storage-battery reserve being maintained to keep the direct-current network alive in emergencies.

The latest rotary converters purchased are of the vertical-shaft type. One of these 2000-kw machines in the Market Street substation is illustrated in Fig. 20. This machine was described in the Electrical World of Dec. 28, 1907. The weight of the armature is carried by a roller bearing. An oil step-bearing can be substituted quickly for this should the roller bearing fail. The advantage of the vertical-shaft converter is a reduction in headroom and floor area, more accessible commutator and brushes, and less journal friction. There is also a saving of about 17 per cent in the weight of the vertical-shaft

machines, as compared with the horizontal-shaft machines this company has in service.

The alternating-current territory is supplied with energy from motor-generator substations which receive 25-cycle, 9000-volt, three-phase current and deliver 60-cycle, three-phase current for distribution over a three-phase, four-wire system, the neutral of which is grounded. The e.m.f. between neutral and any one of the outer legs at full load is about 2200 volts, while that between the outer legs is 3800. Single-phase lighting feeders are connected between the neutral and the outer leg of the circuit.

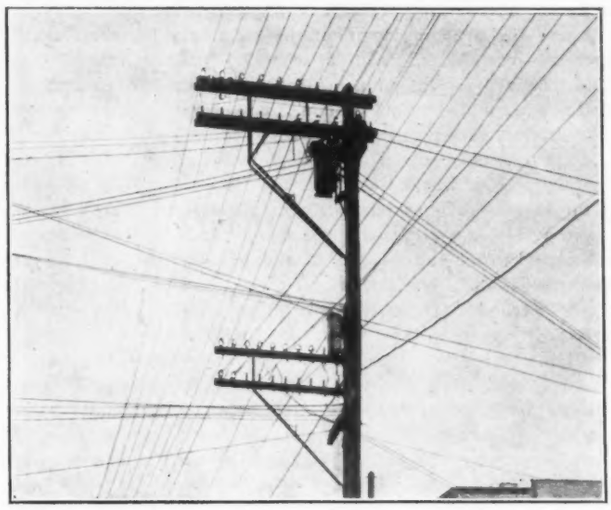


FIG. 24.—TYPICAL JOINT-POLE CONSTRUCTION.

Three-phase motor circuits are operated Y-connected between the neutral and the three outer legs, thus obtaining the benefit of 3800-volt, three-phase transmission. This system combines the advantage of a standard 2200-volt, single-phase independently regulated lighting distribution with 3800-volt transmission for heavy loads.

In the motor-generator substations from which 60-cycle alternating energy is supplied, the high-tension switches and busbars are similar to those used in the direct-current substations described above. Of course, no step-down transformers are necessary, as the synchronous are joined directly to the 25-cycle 9000-volt substation busbars. To maintain the 60-cycle generators at constant voltage, Tirrill regulators are employed in the field circuits of the exciters. The 60-cycle bus e.m.f. is kept at a fixed point by these regulators, and the necessary raising and lowering of the e.m.f. on the feeders is accomplished by motor-operated induction regulators. One of these is connected in each lead of every outgoing feeder, so that the phases can be regulated separately.

Vertical-shaft motor-generators were employed in these substations before vertical-shaft rotary converters were perfected. The 2000-kw motor-generator with vertical shaft in the West Madison Street substation is illustrated in Fig. 21. This machine has a step bearing, the weight of the revolving shaft being carried by a film of oil under pressure as in a Curtis turbine. The motor-generators are started through auto-transformers with alternating current. One advantage of the vertical-shaft machine with oil step-bearing is a reduction of the initial starting current because the standing friction of the step bearing is less than that of common horizontal bearings. For more detailed descriptions of substation practice and construction of this company the reader is referred to articles in the ELECTRICAL WORLD of Dec. 1, 1906, July 27, 1907, and Dec. 28, 1907.

DIRECT-CURRENT DISTRIBUTING SYSTEM.

The three-wire direct-current distributing system from substations is arranged on the feeder-and-main plan as regards the positive and negative wires. The neutral feeders are connected according to a kind of "tree" method. From the substations positive and negative feeders extend to various points where they tap into the mains. The mains, which extend along the streets, are tapped for consumers' service connections as often as necessary. The mains form a complete interconnected network in normal operation, but each block of mains can be separated from the network by the blowing of fuses in junction boxes, through which each section of the main is connected to the network. Many of the mains are constructed of the old Edison tubing. The newer circuits are of lead-covered cable in vitrified clay conduits. In the conduit construction, Tailleur junction boxes are used for the fuses which interconnect the mains. Short strip copper fuses are employed, the copper being much narrower at the middle of the fuse than at the terminals. These fuses are made so large that they will not blow at less than a heavy short-circuit current. In a 1,000,000 cir. mil cable a 2000-ampere fuse is used. In addition to the service mains there are also some tie mains, so that feeders supplying energy to mains in one vicinity can assist the feeders supplying neighboring mains in case of an extra heavy load at one point. The feeder-and-main plan is not used on the neutral because it does not utilize the neutral copper to best advantage. For example, if an unbalanced load requires a flow of electricity through the neutral from one part of the distribution system to another over the neutral feeders, such current as would exist in the neutral feeders would flow to the substation. With the neutral feeders connected on the "tree" plan, with plenty of taps between the substation and the end of the feeder, there is more opportunity for the unbalance current to be utilized to correct unbalance on the other side of the system before reaching the substation.

Neutral feeders and mains, when installed in conduit ducts, are of bare copper cable. Positive and negative feeders in the latest standard practice of the company consist of 1,000,000 circ. mil concentric cables. The concentric feeder cable has stranded inner and outer conductors. Woven in with the stranded outer conductors is a No. 14 insulated wire, the diameter of which over insulation is the same as the diameter of the bare wires forming the outer conductor of the cable. These are used as pressure wires, to which the substation voltmeters are connected for indicating the e.m.f. at feeder ends.

In most of the substations three sets of busbars are used to provide for three voltages—a high e.m.f. for the very long

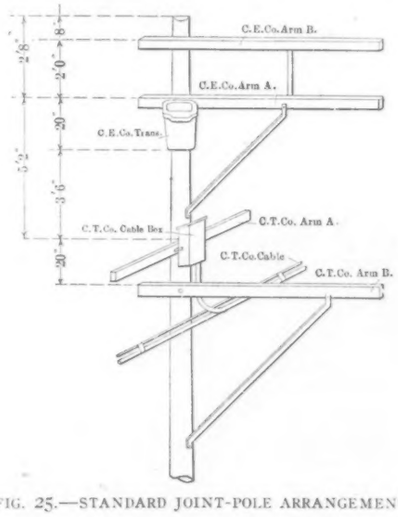


FIG. 25.—STANDARD JOINT-POLE ARRANGEMENT.

feeders, a low e.m.f. for the very short feeders, and a medium e.m.f. for the medium-length feeders. In some substations only two buses are used. As substations are being established at short distances apart in the down-town district, the tendency is to reduce the e.m.f. drop in feeders so as to require a smaller number of busbar voltages. The lamp e.m.f. is 115 volts. During the peak load on some of the short feeders, the e.m.f. is from 118 to 122 volts at the substation. On the longest feeders connected to the highest voltage busbars, the e.m.f. sometimes reaches 135 volts during peak.

Some portions of the down-town district of Chicago probably

show the highest central-station load density to be found anywhere in the world. A half mile on State Street, which is the principal retail shopping street, has a load of 5000 kilowatts. Some portions of this distance show much greater density than this. In this half mile are many department stores. Not all of them, however, are purchasing energy from the company.

Some of the large customers have feeders from two or three neighboring substations, as well as connection directly with the street service mains. As an interesting example of the security to service made possible by this arrangement, cases are on record where a severe short-circuit current occurred in the street mains near a customer's building. This current resulted in blowing the junction-box fuses at each end of this street main and also, by virtue of the energy fed back from the busbars of the large consumer's switchboard, the fuses connecting the consumer's busbar with the street mains were blown. The service was uninterrupted, however, as the fuses did not blow in the two feeders which connected the customer directly with two neighboring substations. The customer was unaware that anything unusual had happened.

A number of storage batteries are located at various points in the direct-current distribution system. These batteries, however, are kept almost entirely as emergency reserve, and are not ordinarily discharged even during peak load. They are discharged about once a month for test to keep them in good working commission.

The 1,000,000 cir. mil concentric feeder cables are worked at about 1100 amperes for an hour during peak loads if necessity requires. This is not likely to be continued long, however, because when the maximum load reaches that point additional feeders are put in service. The concentric feeder cables have paper insulation 5/32 in. between conductors and the same outside.

In a typical example of service main construction in some recent work, manholes are placed at street intersections and at the alley intersections. At street intersections service wires can be run off diagonally to any one of the four corners and at the alley, and branches are run each way, so that the chances are good for reaching most of the customers without requiring any extra hand-holes. Should there be a customer between the alley and the corner inaccessible from these manholes, the street is opened, a service main exposed, a hand-hole made and a branch line tapped into the main at the point where needed.

ALTERNATING-CURRENT DISTRIBUTING SYSTEM.

In the alternating-current distribution from substations to consumers the Commonwealth Edison Company meets all kinds of conditions, from those of a large city to those of the smallest town, there being outlying suburban districts where conditions are almost identical with those in a small town. The general practice is to use one lighting transformer for each 660-ft. block. In most of the territory an interconnected secondary network fed by a number of transformers is impracticable because of local conditions. To interconnect the secondaries from one block to another would require about 25 per cent increase in copper, and it is not considered that the advantages in the majority of cases would justify this expense. There are, however, a few places where secondaries are interconnected and fed by several transformers. In such cases there are placed in the secondaries midway between transforms fuses which will blow and isolate any transformer in case of trouble. These fuses are common open-link fuses mounted on a slate block placed in a wooden box. The fuses are rated at about one-half the output of the neighboring transformers.

The great majority of the pole lines are run in alleys, and, in some cases where there are no alleys, along rear property lines by permission of the owners. The usual lot width in Chicago is 25 ft. Poles are generally placed 125 ft. apart. Secondaries are arranged three-wire, the lamp e.m.f. being from 113 to 115 volts. Estimates for wire are on a basis of 2 per cent maximum drop in voltage between the transformer and the farthest customer. The transformer ratio is such that 115 and 230 volts are delivered on the secondary with 2080 volts primary. The neutral wire of all secondary lighting circuits is grounded, and one point of each three-phase motor circuit is grounded, as will be explained later.

The grounding of transformers and lightning arresters is accomplished by driving a 5/8-in. galvanized-iron pipe 10 ft. into the ground. A G. & W. pipe-cap is placed over the end of the pipe before it is driven, this cap performing the double function of protecting the end of the pipe during driving and making the electrical connection between the end of the pipe and the ground wire. The ground wires are of No. 6 or No. 4 copper, and they are protected in molding partly for mechanical reasons and partly to avoid shocks to persons who may come in contact with them, should the ground connection be accidentally broken.

Where the arc-lamp load on the secondary becomes larger than the incandescent load, a separate arc-lamp transformer and secondary service main are installed, unless there are less than five arc lamps. This method is used because of the voltage drop in secondaries and transformers caused by arc-lamp load.

Motors are also placed on separate transformers from lighting load, except where the motor load is a very small fraction of the lamp load on a transformer. Motors rated at 5 horse-power or less are required to be single-phase, as the company will not go to the expense of installing three-phase service with two transformers for such small motors. The company will supply energy to any single-phase motor in which the starting current is not over three times the full-load running current. The same restriction is made on three-phase motors.

In residence districts transformer rating equal to 15 to 20 per cent of the connected load is installed. The higher ratio applies to secondaries supplying energy to a large number of small consumers. The transformer rating used in determining these transformer ratios is based on an eight-hour full load, according to customary transformer rating. It is considered that transformers can operate with entire safety at from 25 to 33 per cent overload for one or two hours per night. In manufacturing and mercantile districts the transformers installed are rated at 75 per cent of the connected load. The transformer rating on motor installations of over 25 horse-power is usually 50 per cent of the connected load. On installations of from 100 to 300 horse-power it is 70 to 80 per cent of the connected load.

Transformers having a total rating of 38,000 kilowatts are connected to the 60-cycle distributing system. There are 5600 transformers. The connected alternating-current load totals 71,000 kilowatts, of which 50,000 kilowatts is for incandescent lamps, 2500 kilowatts for arc lamps, and 18,500 kilowatts for motors. The average transformer rating is, therefore, 53.5 per cent of the connected load for all classes of business.

The same kind of transformers are used for lamps and motors, the only difference being in the method of connecting the secondaries. The smallest transformer used is rated at one kilowatt. No transformers larger than 50 kilowatts are used. If more output is needed than this, additional transformers are installed. The reason for this limit is partly the unwieldiness of large transformers, but mainly the fact that there are so few places where transformers of over 50 kilowatts are needed that it is not thought wise to keep the larger sizes in stock. The oil is replenished in transformer cases yearly.

Transformers for three-phase motors are joined with their primaries in Y-connection between the neutral and outside wires of the circuit. This connection impresses the regular 2080-volt primary e.m.f. upon them and gives a secondary e.m.f. of 230 volts. The 230-volt secondaries are connected in "delta" for the motors. The middle point of one of these delta-connected secondaries is grounded. For miscellaneous small three-phase motors only two transformers are installed. If a motor rated at from 15 to 20 horse-power is put in, three transformers are ordinarily used; this rule is not rigid, local conditions modifying it. Fig. 22 illustrates the method by which new territory having both motor and lamp loads is built up. From a substation located, for example, at *A*, four wires are run to a distributing center at *B*. From this center single-phase lighting feeders branch off in three directions. These feeders use the common neutral from the substation at *A* to *B*. Aside from this, each of these feeders is independent of the others, volt-

age regulation being inserted in each feeder at the substation to maintain the proper voltage at feeder ends. If there is a demand for motor service along any one of these single-phase feeders, as, for example, at *C*, an additional wire is connected to the other phases at the distributing center *B*, as indicated by the dotted line. These wires are of smaller diameter than the single-phase lighting feeder. If larger loads develop two more phase wires are put in for motors, as at *D*. The neutral and single-phase lighting feeders already up are used for one phase of the motor circuit and the two additional smaller wires furnish the other two phase leads. This arrangement utilizes one of the great advantages of the three-phase four-wire system

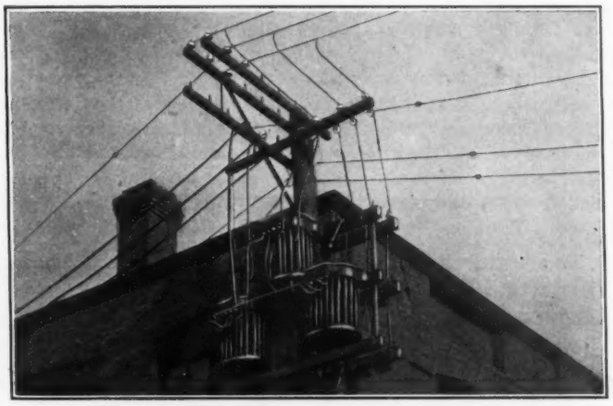


FIG. 26.—TRANSFORMERS IN INDUSTRIAL SERVICE MOUNTED ON POLE.

for this miscellaneous class of work. Each single-phase lighting feeder can be regulated independently as to voltage for lighting purposes, and at the same time used to supply energy to one leg of the three-phase motor circuit.

All of the 2080-volt distribution system is laid out on the feeder-and-main principle, as indicated in Fig. 22. From the substation, feeders lead out to distributing centers where they join the mains from which transformers are supplied with energy. The mains may extend in any direction from the feeder end. Some of them, of course, extend back parallel with the feeder. An attempt is made to limit the maximum voltage drop to 2 per cent at full load between the end of a feeder and the most distant transformer on a set of mains. The drop at full load between the substation and the end of a feeder averages about 5 per cent. The conditions never require mains larger than No. 6 wire, so this size is made the standard. The standard size of feeders is No. 0, and the maximum load on a feeder is 100 amperes or 200 kilowatts. When the load on a feeder would exceed this value, additional wires are installed.

About one-half of the main feeders are laid underground. Most of the mains are erected overhead in alleys. In fact, about 90 per cent of the overhead work is located in alleys. The feeders average about 1½ miles in length, the short length being due to the frequent location of substations, local conditions, rather than reasons of electrical distribution having required the placing of substations at such intervals.

In a few cases where alleys have not been available, and underground work was necessary, transformers have been used in manholes. This construction is avoided as much as possible, however.

All primary mains are connected according to the "tree" method, and there are no closed loops, because in most cases there is little advantage to be gained by such loops; moreover, they are likely to cause accidents to linemen who think that a line is dead when it has been opened at one place, but is being fed with energy from the other end. No fuses are placed at branches except in a few places where there is a current of only 10 to 15 amperes. Large fuses on poles have been found unreliable. Disconnecting boxes, however, are provided at branches so that a branch circuit can be disconnected for repairs.

When passing from overhead to underground circuits, the lead-covered underground cables are brought up the pole in iron pipe and terminate in G. & W. porcelain potheads, as in Fig. 23; these pot heads also serving as disconnecting switches. The shell of the pothead, which is of porcelain, is placed over the end of the cable and poured full of "Minerallac" compound. The overhead line terminates in a brass plug with a porcelain cap which slips over the pothead.

A typical piece of overhead distribution construction is shown in Fig. 24. Poles are located on one side of an alley, side arms with braces being used. When the poles are set they are given about 1 ft. "rake" toward the property line, so that the weight of the wires will tend to straighten them. Nearly all of the lines are held on poles owned jointly by the Commonwealth Edison Company and the Chicago Telephone Company, there being some 25,000 such joint poles in use. The standard joint pole is of Michigan cedar, 35 ft. long with a 7-in. top. Larger tops are used on corner poles. There are two cross-arms for each company and one service buckarm. The dimensions of the cross-arm spacings are shown in Fig. 25. The standard distribution line cross-arm has six electric lighting wire pins on the alley side and one on the property side. On poles carrying through lines there are nine pins, eight of which are on the alley side. The secondary wires are placed next to the pole, the primary wires on the outer end. The distance between pin centers is 15½ in. on six-pin arms and 14 in. on eight-pin arms. The electric lighting wires are placed on the top of the pole so that the smaller and more breakable telephone lines cannot fall among the high-tension wires and also so that the telephone linemen will be safer when working on the poles. The insulators for the primary wires are of common double-petticoated glass.

Lightning arresters are placed about 1500 ft. apart. Three kinds are in use—old and new style General Electric and Garton-Daniels. All are placed in wooden boxes.

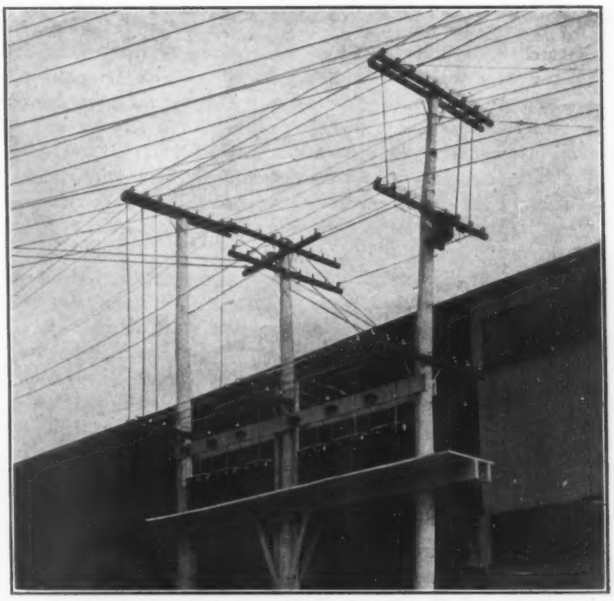


FIG. 27.—TRANSFORMERS MOUNTED ON PLATFORM.

Figs. 26 and 27 show typical transformer installations at large motor customers' in manufacturing districts.

ROUTINE AND EMERGENCY OPERATION.

The routine and emergency operation of a large electrical distributing system with enormous rotory-converter and motor-generator substations connected to generating stations of enormous output, presents operating problems entirely unknown in smaller systems. When the 9000-volt, 25-cycle transmission system began to assume large proportions, the necessity of having all switching operations pertaining to that system under

supervision from a central office became apparent. The generating plants supply energy to the substations through 9000-volt transmission lines running directly from the generating plant to the substation. To supplement these lines there are also some tie lines connecting the substations for emergency use. The necessity for central supervision is further emphasized by the fact that in normal operation two separate electrical systems are maintained, part of the generators used feeding energy into "A" system and part into "B" system. These systems are, of course, not operated in parallel, but their separate frequencies are maintained so nearly the same that they can easily be joined in parallel at any time on short notice. However, with busbars in the same substation receiving energy from separate sources the chances for throwing these two systems together when not desired would be great if the substation operators were allowed to perform the high-tension switching without central supervision. All companies having such large systems maintain a central supervision of this kind, called by various names. The term "load dispatcher" was selected by this company as indicating the responsibility of the man who has charge of the electrical operation of the system, this responsibility corresponding to that of the train dispatcher on a railroad, without whose authority no trains can move.

In a quiet room, Fig. 28, at the company's headquarters, 139 Adams Street, there will always be found on duty one, two or three load dispatchers, the number being varied according to the time of day. From this room direct telephone communication can be had with all of the generating and substations. Occupying the sidewall is a large diagram of the 25-cycle, 9000-volt transmission system. This diagram shows all the transmission lines, high-tension oil switches and station busbars connected with the system, and is placed there for the use of the dispatchers in keeping a record of switching operations. On this diagram switches are indicated by holes for pegs. When a switch is closed, a peg is inserted in the hole. Copper-colored plugs are used on the "A" system and green plugs on the "B" system. In most cases the absence of a peg from a hole indicates that the switch is open, but in order to remind the load dispatcher of danger points red pegs are used where the closing of a switch would connect the A and B systems together. The red pegs serve as warnings to the dispatcher not to order any of those switches closed. White pegs are also used as warnings in connection with certain busbars in the Fisk Street station which operate motor-driven exciter units, in order that the supply of current may not accidentally be cut off from these exciter motors without previous provision for exciting current.

In general, the load dispatcher gives orders for the opening and closing of all switches in the 9000-volt, 25-cycle system, but there are some important exceptions to this rule. For example, in case a substation which is supplied with energy over two transmisison lines has the circuits suddenly opened. The substation operator will immediately synchronize and connect the converters to the other line if he is able to obtain energy over it. To provide for such emergencies, all lines to a substation are normally kept "alive" up to the switch connecting the transmission line to the substation busbars.

In case of a short-circuit on the system causing the rotary converters supplying energy to the down-town direct-current network to be thrown out of step and consequently disconnected from the 25-cycle system through the opening of overload switches, the emergency storage batteries immediately discharge into the system, as they are kept floating on the line. Battery attendants have orders immediately to connect in enough end cells to hold the e.m.f. on the system as near normal as possible. The batteries may be discharged up to as high as three times the regular one-hour rate. The rotary converters are run up to synchronizing speed from the direct-current end and again connected to the system. In the alternating-current substations, of course, no such reserve exists.

The substation operator is instructed to get the machinery into operation from any remaining good line as quickly as possible without calling the load dispatcher and notify the dispatcher afterward. An operator noting some disturbance not serious enough to throw the machines out of step must not call the dispatcher until five minutes have elapsed, because if all substation operators were to call the dispatcher at each time of slight disturbance confusion would result. The Fisk Street station in the ordinary routine of connecting and disconnecting units to conform to the load, is allowed to connect units to the busbars and notify the dispatcher subsequently. In case of a disturbance on either the "A" or "B" systems, one of the first procedures of the operator at the Fisk Street station is to parallel the two systems, so that the undisturbed system may help out the one in trouble.

The large diagram on the wall in the dispatchers' office indicates merely the 25-cycle busbars, switches and lines. There are between 500 and 600 oil switches on this system. The elementary busbar diagrams of the various substations are kept in the form of drawings under a glass plate on the dispatcher's desk, where it is in plain sight as he answers the telephone. The telephone switchboard which gives the dispatcher communication with the entire system is divided so that two dispatchers can work at once. The e.m.f. at two substations is indicated by voltmeters in front of the dispatchers, one of these substations being on the "A" system and the other on

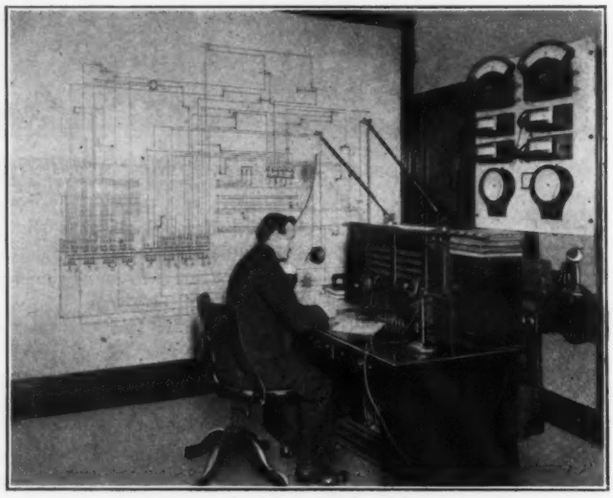


FIG. 28.—LOAD DISPATCHER'S ROOM.

the "B" system. Two voltmeters also show the feeder e.m.f. at two points in the down-town direct-current network. The dispatchers also have in convenient reach complete necessary data on routes of feeders, feeder tunnels, etc.

Although the street and elevated railway substations are not owned by the Commonwealth Edison Company, their operators are subject to orders of the load dispatcher as far as high-tension switching is concerned. There are in all 41 substations under the dispatcher's orders. To prevent misunderstandings, all orders are repeated back to the dispatcher after being received. An order from the dispatcher is required before any alteration or construction work is done around stations.

During the peak load, three dispatchers are on duty. At all other hours two are on duty, except after midnight until morning, when one of these two is allowed to sleep in the building where he is within immediate call of the one on duty. The dispatchers work in three shifts, a total of five dispatchers being required. Each dispatcher is off regular duty two days out of every eight. One of these days is for rest and recreation; the other day is for visiting stations and substations, getting acquainted with conditions in each substation and becoming familiar with the men and methods of operation. Load dispatchers are promoted from the ranks of chief substation operators, and so have had a very complete operating experience.

TRAINING OF OPERATORS.

Substation operators are very carefully picked and trained, the training and discipline of these men having reached a

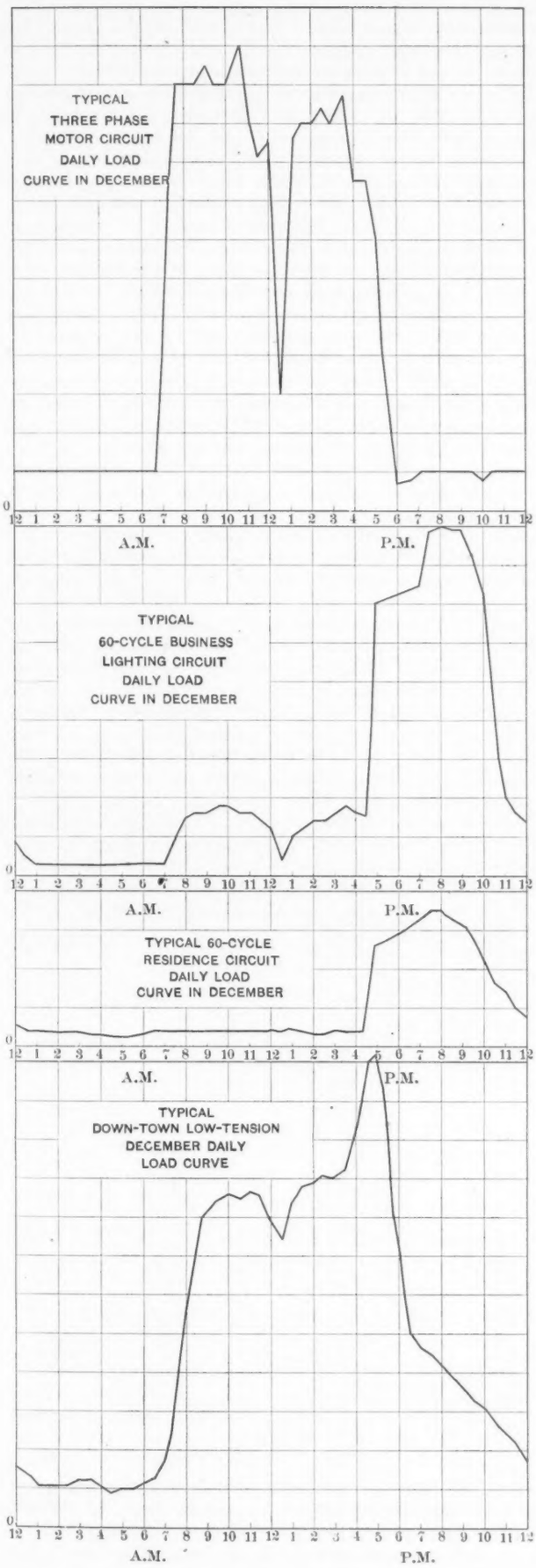

TYPICAL
THREE PHASE
MOTOR CIRCUIT
DAILY LOAD
CURVE IN DECEMBER
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A.M.
P.M.
TYPICAL
60-CYCLE BUSINESS
LIGHTING CIRCUIT
DAILY LOAD
CURVE IN DECEMBER
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A.M.
P.M.
TYPICAL 60-CYCLE
RESIDENCE CIRCUIT
DAILY LOAD
CURVE IN DECEMBER
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A.M.
P.M.
TYPICAL
DOWN-TOWN LOW-TENSION
DECEMBER DAILY
LOAD CURVE
0
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A.M.
P.M.

FIG. 29.—TYPICAL LOAD ON THE SYSTEM.

high state of perfection. Of the applicants for the position of operator, only about 5 per cent have qualifications which cause them to be considered. An applicant, to be considered, must have at least a high-school education, and in addition must have completed either correspondence school work or taken evening courses in electricity. To be in line for promotion, the applicant must have at least completed and graduated from a correspondence school course or something better. Voltmeter readers and battery boys not eligible to promotion are sometimes taken without the educational requirements mentioned, but these are not eligible for promotion until they have qualified by graduation from a correspondence school course or by night school work. From 10 to 15 per cent of the men have attended college, most of them in electrical courses of technical schools. Over 50 per cent of the men are correspondence school graduates. Many have also taken evening courses at Lewis or Armour Institutes in Chicago, both of which institutions have been doing excellent work in this line during the past few years.

Very few experienced substation operators apply for positions. The company has to train most of its operators from the beginning. A few who have operated in interurban railway substations apply, but the knowledge required is so much less in the latter substations than it is in Commonwealth Edison substations that interurban railway experience is considered only a beginning. Nothing short of graduation from a correspondence school course is considered in connection with correspondence school work, because of the observed fact that only about 10 per cent of those starting correspondence school work persevere to complete it. Applicants are discouraged rather than encouraged when making application, in order that the men who lack determination and persistence and who are looking for easy jobs may be weeded out. Applicants, when first put to work, are rated as apprentices during a preliminary period of training, extending over from one to six months. During this time they work 10 hours a day and receive 17½ cents an hour. They are then assigned to their first responsible operating shift in the grade of third operator, at the rate of 22¼ cents an hour for nine hours a day. From the grade of third operator they are promoted to second operator and then to chief operator in charge of a substation. All men in responsible charge (that is, from third operator up) are over 21 years of age. To pass from one grade to another, an examination is required before a board which consists of the general inspector, the general operator, the district operator and the chief operator of the station in which the man works.

In the 33 substations belonging to the company, about 150 men are employed, of which 80 are certified operators who are in responsible charge and have passed out of the grade of apprentice by examination given by the board and have the certificate of the superintendent of substations. The requirements for acceptance of a man as apprentice to begin with are in general as follows: He must be acquainted with the fundamental principles of electricity and magnetism. He must be free from physical defects, especially those of sight or hearing, and must be able to hear well and make himself understood well over the telephone. His character is carefully looked into, references being followed up. References to a banker or a minister are preferred. The ability to stay awake is another qualification looked into as far as possible by testimony of previous employers, because men are frequently alone on duty in substations during part of the night. Preference is given to men having had practical mechanical or electrical experience. The training of an apprentice before promotion averages about five months.

The examination for promotion from apprentice to third operator includes familiarity with operating rules and general orders of the company. He must be able to draw without hesitation a complete wiring diagram of a substation, including both the main and the control circuits. He is examined as to maintenance of equipment and as to his appreciation of the value of seconds in getting service restored after an interruption. He is also examined as to his appreciation of precautions and care necessary to preserve life and property which

may be jeopardized by his actions. He is also put through regular operating work by the chief operator. To pass to the grade of second operator, he is again examined to be sure that he has not allowed himself to become "rusty," and his operating record is also considered. To test operators' performance under the fire of actual emergencies, sham interruptions of transmission lines are frequently sprung on the substation

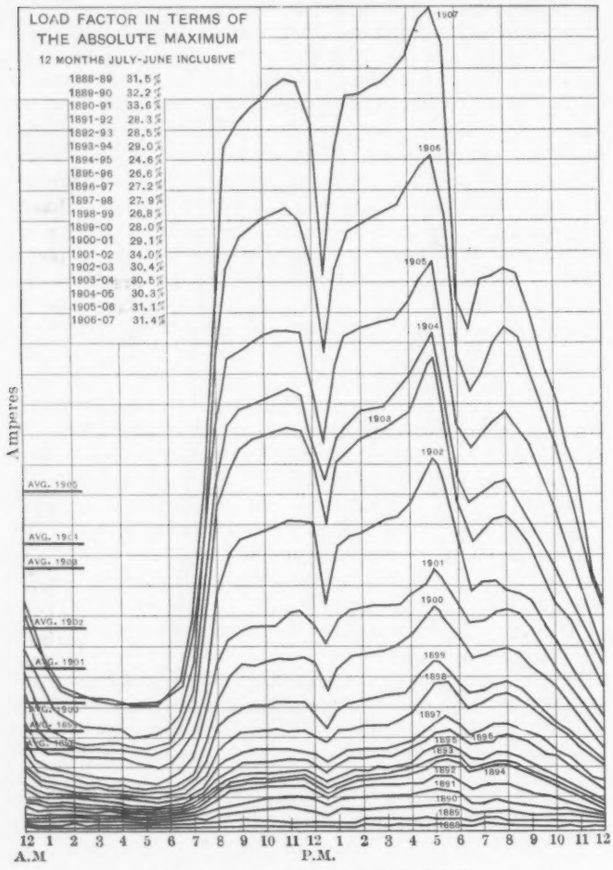


FIG. 30.—COMPOSITE AMPERE CURVE.

operators at times when someone is around with a stop watch to see how much time is consumed by him. Of course, nothing which in any way interferes with the service can be tolerated in this respect, but it is frequently possible to interrupt a transmission line to a substation when the load on the substation is light, without interfering with the service supplied by the substation. It is, of course, impossible to reproduce the worst emergency conditions in order to test the operators, and the best that can be done is to explain continually, and educate, as to the procedure in extreme emergencies and then to rely on the discipline of the men to carry out the instruction when the emergency arises.

METER DEPARTMENT.

The company maintains under separate management three departments for testing. The meter department sets, removes and tests consumers' meters. For the regular testing and calibrating of the hundreds of switchboard instruments and watt-hour meters a separate department is maintained in connection with the company's laboratories. The laboratories constitute a department of engineering testing for the purpose of carrying on electrical and photometric tests of various kinds on matters upon which the company needs information. Space does not permit describing the work of all these testing departments, but that of consumers' meter testing will be taken up briefly, as being of much practical interest to both large and small central-station companies.

The company has in use commutator-type watt-hour meters on the down-town direct-current system and single and polyphase 60-cycle induction meters in the outlying districts. After considerable investigation, this company several years ago adopted a schedule for the testing of meters whereby the frequency of test of the consumers' meter is somewhat in proportion to the size of the meter and the amount of money involved in the monthly bill. The classification adopted for commutator meters was as follows:

Annual tests for meters of from 5 to 10 amp rating.
Semi-annual tests for meters of from 15 to 50 amp rating.
Quarterly tests for meters of 75 amp rating and above.

Meters making over 1,000,000 revolutions of the disk between tests under the foregoing classification are changed to a more frequent class so as not to exceed 1,000,000 revolutions between tests. It is not, however, considered necessary to test any meter oftener than once in three months. Where a meter has not retained its calibration for this length of time, an investigation has been made, and the rapid loss of accuracy is usually found to be the result of commutator trouble caused by excessive vibration or heavy momentary overloads. All commutator meters are being equipped with cupped diamond bearings to replace the sapphire bearings formerly used.

Induction meters on alternating circuits, it is found, can safely be allowed to run much longer without test. Single-phase meters rated at 50 amp or less are allowed to run from one to two years between tests. Those rated at over 50 amp and polyphase meters are tested every six months. Meters are inspected and cleaned and adjusted to run freely on a light load after installation on a consumer's premises, but are not tested. This plan is the result of investigations which show that the initial inspection results in greatly improving the average accuracy of meters. Meters are tested in place on the consumer's premises. For giving a testing load, a lamp bank is used for loads not exceeding 50 amp. For larger loads the consumer's lamps are used in addition to the portable lamp bank. In testing meters on motors the consumer's motor load is used in order to test the accuracy of the meter under actual working conditions of power factor. The present practice is in the direction of testing meters with a portable master watt-hour meter. About one-third of the force now checking meters carry the portable watt-hour meter with several field coils for testing different ratings of meter, and all new equipments con-

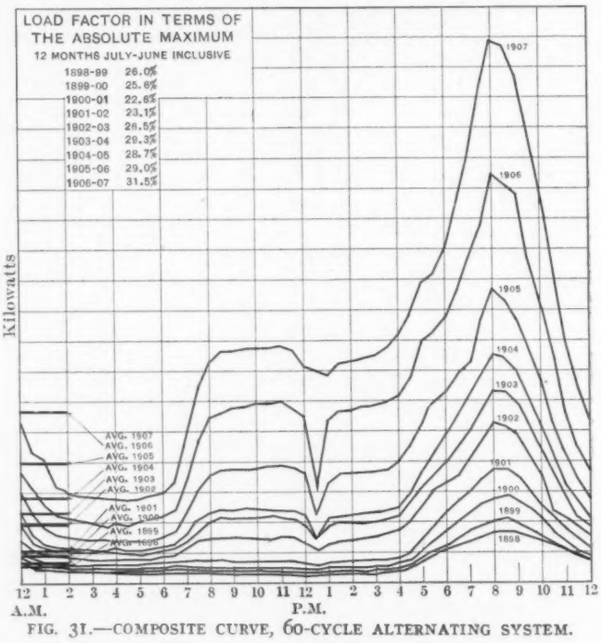


FIG. 31.—COMPOSITE CURVE, 60-CYCLE ALTERNATING SYSTEM.

sist of the watt-hour meter rather than the indicating instruments formerly used. Meters are usually tested at one-tenth load and at one-half load; one-half load being considered as representing nearer the running condition of the meter than full load.

A study of the character of the load in a large system of this kind is a matter of considerable interest to both large and small

companies. It is also of value to observe what changes in the character of the company's load have taken place from year to year. In order to show the different characteristics of the electric lamp and motor load carried by this company Fig. 29 has been prepared. This illustration shows a typical load curve for a December day of the following: The down-town low-tension network which supplies energy to electric lamps and motors in the down-town district; a typical 60-cycle, alternating-current residence lighting feeder; a typical 60-cycle feeder devoted mainly to business lighting in an outlying district; and a typical three-phase motor circuit running to a manufacturing district. As December is the peak-load month of the year, these curves serve to indicate the extent to which the maximum yearly demands of these four classes of business overlap. On the down-town low-tension network, which is, of course, the heaviest portion of the company's load circuit, it is seen that the peak occurs a little before 5 p. m. and that it falls rapidly after that time until after 6, after which the falling off is more gradual until midnight. The 60-cycle residence and business lighting circuits are very similar in general form, each reaching its peak at 8 p. m. However, both reach about 75 per cent of their maximum at the time that the down-town peak occurs. The three-phase motor circuit reaches its peak in the morning and it decreases to half its maximum demand by the time of the down-town peak. The aggregate peak load from all classes of business, or, in other words, the station peak, occurs at about 5 o'clock.

Figs. 30, 31 and 32 show load curves obtained by averaging the load at each hour of the day for an entire year. While these load curves, therefore, represent the average load at every hour of the day for a year, they do not represent the form of curve which would be obtained during the peak load period of the year in November and December. The load

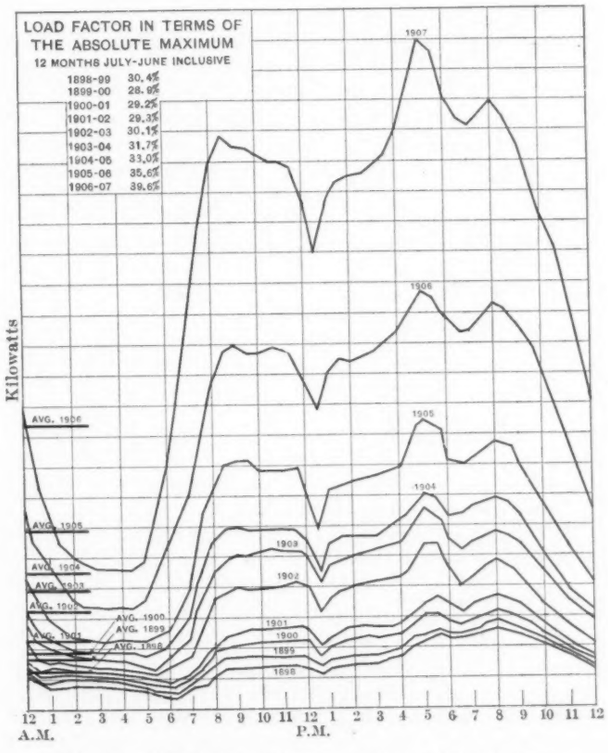


FIG. 32.—COMPOSITE KILOWATT CURVES, TOTAL OUTPUT.

factors which accompany the curves (Figs. 30 to 32) are not calculated from the curves, but are calculated from the actual maximum load of the year and the actual kw-hours output. Beginning with Fig. 30, which shows the load on the down-town low-tension system, it will be seen that the yearly load factor for last year was 31.4 per cent, or almost the same as for the year ending June 30, 1889. In the 19 years covered by these curves, the load factor has at times been better and worse than this, due probably to circumstances which affected the peak. The failure of the load-factor to improve with the increasing use of electric motors is probably to be explained by the increasing number of tall office buildings, the lighting load of which has a notoriously bad load-factor.

The load-factors indicated on Fig. 31 for the 60-cycle alter-

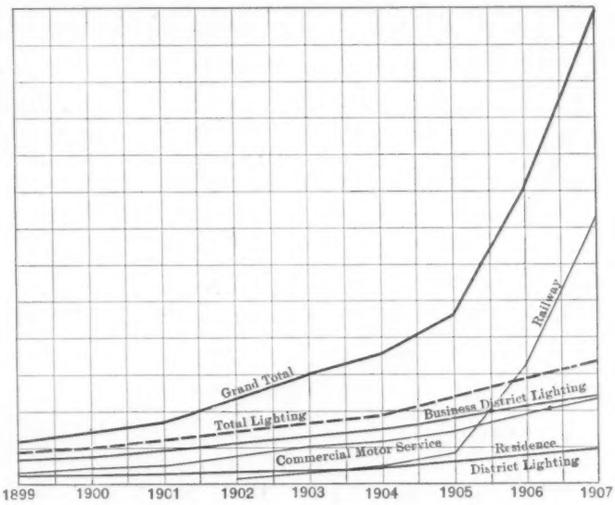


FIG. 33.—ANNUAL OUTPUT KILOWATT-HOURS SOLD.

nating-current system for a period of nine years, show a decline for the first part of that period and an increase for the latter part. Any increase in the load-factor for the 60-cycle system is to be ascribed to the increasing use of motors in the outlying manufacturing districts. But for the fact that the residence lighting has greatly increased in the nine-year period, the effect of the motor business in improving the load-factor would be much more noticeable.

The load-factors for the entire system, both direct and alternating current (including also the railway load, which has recently risen to a point where it represents half the output) are shown in Fig. 32. From this it is seen that since 1903 the load-factor has been rapidly rising, due, of course, to the railway business. Fig. 33 shows curves indicating the relative number of kw-hours sold each year for various purposes from 1899 to 1907, and also the grand total. From these it will be noted that the rapid increase of the railway business since 1905 is responsible for the sudden increase in the energy sold for the past two years. In the electric lamp and motor service the increase has been very uniform, although all classes of lighting and industrial service show an increased rate of growth beginning with 1904. Among the causes which contribute to this increasing rate of growth are the lowering of the rates and the completion of the Fisk Street station so that the company was prepared to handle the rapid growth. There is certainly nothing about the curves, Fig. 33, to indicate that the saturation point has been reached, but rather to indicate that an increasing rather than a decreasing rate of growth is to be expected.

Spinning Machines.

A paper was read recently by Mr. Schnetzler before the Dresden Electrical Society on the electric driving of spinning machines, especially on the methods used by Brown-Boveri & Company. Direct connection with the motor is thought to be essential. The ordinary induction motor with squirrel-cage armature is excellent when change of speed is thought to be unnecessary and when an increased number of breaks of the thread during starting is considered to be a matter of small importance. If variations of speed are desired the direct-current shunt motor should be used if direct current is available. For alternating-current systems the Deri repulsion motor is recommended.

Electrically-Propelled Fire Boats for Chicago.

THERE are now being built at Manitowoc, Wis., two fire boats for the fire department of the city of Chicago which will be ready for service by the middle of this summer. The boats are fitted with twin screws driven by electric motors, and altogether show one of the most interesting applications of electricity yet made in craft of such importance and size.

HULLS.

The boats are 120 ft. over all, 109 ft. 6 in. between perpendiculars, 28 ft. molded beam, 15 ft. molded depth and will have a draught of about 9 ft. 6 in. They are constructed of steel throughout, practically no wood being used anywhere except for the inside finish of the deck house and pilot house. The forefoot is cut away considerably, both for convenience in handling and for breaking ice, and the bows at the water line are heavily strengthened also for the latter purpose. There are five bulkheads, of which four are watertight, and lower decks forward and aft, dividing the hull into six watertight compartments.

With the exception of the engine-room skylight, the low boiler trunk and a deck house immediately forward of it containing a toilet room and a large hose room, with pilot house on top, the deck is flush. A plate bulwark forward continues back to the deck house, from which an open iron rail extends aft supported by cast-steel stanchions. Two lines of heavy iron trough-shaped fenders run all fore and aft on the outside of the hull.

SPUDS.

The Chicago River, where these boats will be used, is in many places 200 ft. or more wide and the buildings extend right to the water's edge. The depth of the river is about 20 ft. Since the opening of the Drainage Canal to the Mississippi there is at all times a considerable current in portions of the river. In order, therefore, to hold the boats in a position where they can do effective work on a fire at the river bank, where lines cannot be made fast to moor them, they are fitted with spuds like a dredge, two forward and one aft, working through wells in the bottom of the boat, and raised and lowered by steam power. These spuds are made of double thick steel pipe, 18-in. diameter, stiffened internally by heavy plates and angles, shod with cast-steel points to take hold of the river bottom, and made watertight to reduce the apparent weight to be handled.

For facility in manœuvring in the narrow and crooked river and in the slips, where the boats have to work, they are fitted with twin screws and also with steam steering gear. By working one screw ahead and the other astern, the boats can be swung completely around as on a pivot in either direction.

MACHINERY.

The arrangement of the machinery on these boats is novel in that the same engines are used for operating the fire pumps and propelling the vessel, thus entirely doing away with separate propelling engines. Each boat is fitted with two centrifugal fire pumps, built by the I. P. Morris Company, of Philadelphia. These are of the two-stage type with 14-in. suction and discharge and capable of delivering together 9000 gal. of water per minute at a pressure of 150 lb. per square inch when running at a speed of 1700 r.p.m. By branch pipes properly fitted, the discharge of one pump can be turned into the suction of the other, thereby running the pumps in tandem as one four-stage pump, then delivering 4500 gal. per minute at 300 lb. pressure. This, going through a 3½-in. nozzle, will make a tremendously powerful and effective stream.

At 125 lb. pressure these pumps will each deliver 5500 gal. per minute. One of the great advantages of the centrifugal pump for this service is that the volume and capacity can be varied at will. Combined with this is a smoothness of operation and lack of necessity for attention not found in any other pump, while if inadvertently all discharge openings are closed at once, the pressure would rise but slightly and there would be no danger of bursting hose or anything else. Another great advantage of centrifugal pumps operated by steam turbines is in the fact that the boat can throw her rated capacity of water at all times and also in the great saving of fuel over the ordi-

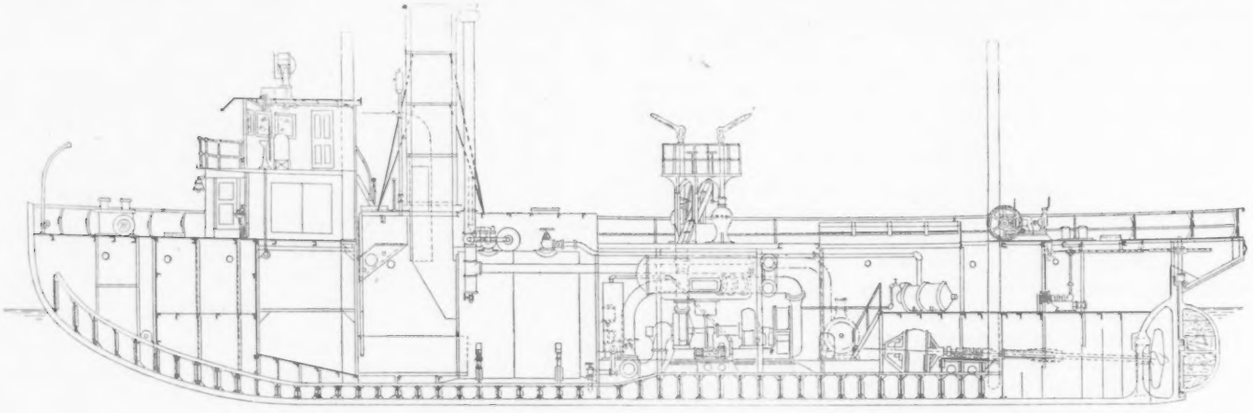


FIG. 1.—ELEVATION OF ELECTRICALLY-PROPELLED FIRE BOAT.

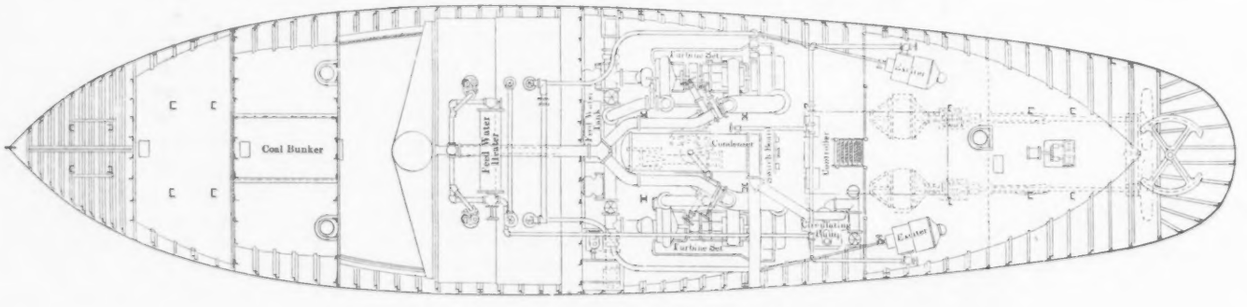


FIG. 2.—PLAN OF ELECTRICALLY-PROPELLED FIRE BOAT.

nary reciprocating pumps, operated with single, non-condensing steam cylinders. The water consumption of the turbine per horse-power per hour is only about 17 lb., whereas with the reciprocating pump it is doubtless at least three times that amount. It is practically impossible to put boilers enough in the boat to supply this amount of steam. Even with the exhaust turned into the stack to force the draft, which means a low efficiency for the boilers, there is probably no fireboat in service to-day with reciprocating pumps that can run those pumps to anywhere near their full capacity.

The pumps are set one on each side of the ship, drawing from a 14-in. header, extending across the engine room immediately forward of them and delivering to turrets on deck directly above. All connections are short and direct and all curves of easy sweep. The deck turrets are set diagonally on deck and each has nine 3½-in. openings for hose with quick-moving lever valves at a convenient height. In the winter these turrets will be enclosed in iron casings to which steam pipes are led to prevent freezing. At a height of about 7 ft. above the turrets is an oval platform carrying the two 3 1/3 in. universal monitors, which are vertically over the turrets and supplied by 5-in. pipes from them. The supports for the platform and the ladder to it come between the turrets so as not to interfere with the hose lines.

Each fire pump is driven by a horizontal Curtis turbine of 660 horse-power, built by the General Electric Company, of Schenectady, N. Y., and directly connected to it on the same shaft and bed plate. This shaft also carries a 200-kw generator of the direct-current type, shunt-wound for 275 volts, for operating the propelling motors. On each of the propeller shafts of the vessel is placed a direct-current, variable-speed reversing motor, shunt wound and designed for operating on the variable-voltage system, developing 250 horse-power at 200 r.p.m. Two turbo-generator exciter and lighting sets, of 25-kw rating, are provided, either of which alone is sufficient. All generators and motors are to be tested by a stream of water from a hose and moisture in the engine room will have no effect on them.

The generators and motors are supplied with independent controllers, two in the engine room and two in the pilot house, with suitable switching devices so that only one set can be in use at a time. A switchboard is installed in the engine room. Between the two turbine sets, high up under the deck beams to save floor space, is a surface condenser built by the Allberger Condenser Company, of New York, with wet- and dry-vacuum pumps directly beneath it. The 10-in. centrifugal circulating pump is on the port side abaft the turbine set. The rating of this pump is 3000 gal. per minute, and it is fitted with a bilge suction so that it can be used for pumping out the engine room in case of necessity. Feed and pony pumps, sanitary pump, etc., are placed on the bulkhead next the boiler room.

BOILERS.

There are two Scotch boilers, built by Johnston Brothers, of Ferrysburg, Mich., in a compartment next forward of the engine room, placed side by side facing forward. These boilers are 12 ft. 6 in. in diameter and 11 ft. 6 in. long between heads, built for a working pressure of 170 lb. In each boiler are two Morrison furnaces, 44 in. diameter, with separate combustion chambers. The boilers have one stack in common and are operated on the closed-stokehold system, the blower being in the engine room.

OPERATION.

In the operation of these boats great speed is not required and therefore the generators and propelling motors are only of moderate power, less than one-half the capacity of the two turbines. The Chicago River is crossed by bridges every block or two, which must be opened for the passage of the boats, so that high speed is out of the question. It was further considered that a combination of circumstances requiring full power on the fire pumps and full power on the propelling motors at the same time for any protracted period is practically impossible, and that if, while the boat is pumping water to her full capacity, the motors are called into service to change her position slightly, the turbines will easily stand the temporary overload. It was for this reason that the electric propulsion was decided upon. The turbines were there anyway for the fire pumps. If ordinary steam engines were used for propelling the boat it meant two more engines with four cylinders, valves, shafts, rods and all the complication and workings parts to take care of and keep in repair. Adding the generators and motors, which practically require no attention at all, added nothing to the work of the engineer, while by the system of control adopted he is even relieved of the necessity of answering bells and operating engines as usual. All this is done from the pilot house, where the captain has a lever under each hand and can control the twin screws, going ahead or back on either or both at any speed instantaneously and entirely independent of the engineer, to whom it makes no difference whether the motors are turning or not. When the boat is lying at her station, under banked fires, waiting for an alarm, the seacocks are closed and the pumps drained of water. When an alarm comes in the engineer has only to start the turbines, circulating and air pumps. The captain starts the propelling motors and on the run to the fire, the power of the turbines is used for running the boat only, the impellers of the fire pumps turning freely in the casings and doing no work. Special arrangements are fitted for oiling the bearings under this condition. On arrival at the fire all the engineer has to do is to open the seacocks and turn water into the pumps without stopping the turbines. As soon as the propelling motors stop, the generators cease to develop power and the armatures turn freely, the power of the turbines then being used for pumping only. If the motors are called upon temporarily to shift the position of the boat the action of the pumps is not interfered with.

When the fire is over and the boat relieved, the engineer simply shuts the seacocks, opens the drains on the pumps and the boat returns to her station.

There are important incidental advantages in driving the screws by motors instead of steam engines. One is that if the boat ever has to go into rough water there is no racing of the screws, the speed of revolution being constant for whatever voltage is being used, which is governed by the controller. It is also possible for short periods to increase considerably the revolutions and power developed by the motors, though this cannot be done for any length of time on account of undue heating. Another advantage is that if a sudden strain is put upon the shaft by the propeller striking heavy ice or against dock piles or other obstructions which are frequently encountered in the confined spaces in which the boats must work, the circuit-breaker opens, instantly opening the motor circuits and there is much less danger of breaking wheels or shafts than if a steam engine were used. Of the machinery installed, the turbines and fire pumps are entirely enclosed and require no attention at all, while the generators and motors entail very little care. As an additional precaution, extra controllers are fitted in the engine room and the engineer can operate the motors on signals from the pilot house as usual, if desired.

A full installation of electric lamps is installed, operated by either one of the turbine-driven exciter sets, and a powerful searchlight is fitted on top of the pilot house.

BREAKDOWNS.

These boats are exceptionally guarded against total disablement by breakdowns of any single part of the equipment, as nearly everything is in duplicate. There are two boilers, two fire pumps, two turbines, two generators, two screws, two propelling motors, two exciter and lighting sets, two feed pumps and two injectors. While there is naturally only one condenser, circulating and air pump, the turbines are fitted with disabling pipes through which they can be exhausted to the atmosphere if necessary, so that any accident which puts the condenser temporarily out of service can only reduce somewhat the efficiency of the boats without causing them to be laid up.

The boats are being built by the Manitowoc Dry Dock Company, of Manitowoc, Wis., from designs of Mr. W. I. Babcock, engineer and naval architect, of New York City, to whom we are indebted for the information presented herewith.

Economical Aspects of the Various Electric Illuminants.

By Alfred A. Wohlauer.

THE cost of light production is a decisive criterion for the selection and final adoption of a certain illuminant. Of course, it cannot be denied that other qualities and features of a lamp, as size or candle-power, light distribution or polar-curve, also the color of the light, have to be taken into first consideration, and that, very often, a certain lamp drops out of the discussion before the question of economy arises. Nobody, for instance, would consider a flaming arc lamp instead of an incandescent lamp when the illumination of a small living room is concerned, or an incandescent lamp for the illumination of a large thoroughfare, or a mercury-vapor lamp for a ball room. As soon, however, as a certain set of lamps is found suitable for a particular purpose at hand the relative cost will determine which lamp should be given the preference.

Furthermore, attention must be called to the fact that the latest developments in the art of lamp making have markedly disarranged and shifted the relative territories of the various lamps. The enclosed arc lamp has found a strong competitor in the tungsten lamp, the flaming arc lamp in the mercury-vapor quartz lamp, etc., so that a readjustment of the boundaries is timely and desirable. A general and up-to-date survey of the whole field of lighting will therefore convey a clear and comprehensive idea of the present situation and considerably assist the estimating illuminating engineer.

The actual or total cost of light production per mean spherical kilocandle-hour is made the basis for the following discussion. It involves not only the cost of electrical energy consumed by a thousand mean spherical candles per hour, but also takes into account the cost for maintenance and renewals. Depreciation and interest of the invested capital will not be considered separately, as they do not materially influence the cost of the kilocandle-hour; moreover, it is impossible to subject the investment cost to the general rules, as the cost of the general outfit of an arc lamp would come in the same category as the cost of fixtures, or at least of shades or reflectors of incandescent lamps, and this would lead too far. The ballast resistance of an arc, vapor and Nernst lamp must certainly be included in the calculations not only as far as the energy consumption of the lamp is concerned, but also, as in the case of the Nernst lamp, in connection with the renewal cost.

The cost of energy consumption per kilocandle-hour

$$C_o = R \times S \qquad (1)$$

R = rate for electric energy per kw-hour, and

S = specific watt consumption per mean spherical candle.

The present article takes into account the mean spherical candle-power as a basis for all lamps. The writer does not consider it feasible to compare mean spherical candles of incandescent lamps with mean hemispherical candles of arc lamps. It would be possible and perhaps also correct to make the mean hemispherical candle the basis for both types of lamps employing reflectors in the case of incandescent lamps and assuming that for both classes of lamps all light is utilized in one hemisphere. The light absorption due to the reflectors, however, has not the same value for the different types of reflectors, and in the case of arc lamps a certain amount of light is thrown uselessly into the other hemisphere, so that the adoption of the mean spherical candle-power is preferable as the most correct basis, while the mean hemispherical candle-power is stated in every individual case, allowing a loss of 20 per cent of light with incandescent lamps for absorption in the reflectors.

The cost for renewal and maintenance is

$$C_r = \frac{P \times 1000}{l \times L_s} \qquad (2)$$

wherein

L_s means spherical candle power

l = life of lamp for incandescent lamps
life of glower for Nernst lamps
life of electrode for arc lamps
life of vapor tube for vapor lamps.

P = price of bulb for incandescent lamps
price for renewal of glower, ballast and for Nernst lamps
price for renewal of electrodes and trimming for arc lamps
price for tube for vapor lamps.

As the average life of the glower of Nernst lamps is 500 hours and the ballast and heater last about 2000 burning hours of the lamp, the price for renewals on Nernst lamps during the period of the life of the glower consists of the price for glower plus a quarter of the cost for ballast and heater.

The cost for trimming of arc lamps varies between 2 and 5 cents per trim on multiple circuits, as was ascertained by the writer from a number of reliable sources, and the corresponding value is added to the price of electrodes.

The total or actual cost of the kilocandle-hour will be thus

$$C_t = C_o + C_r \qquad (3)$$

These three formulas have been used to calculate the data given in the various tables and diagrams.

The abbreviations used in the tables mean:

A = current in amperes
V = voltage of the line
V_a = voltage across arc
W_t = total watts
W_a = watts consumed by arc
L_h = mean hemispherical candle-power
L_s = mean spherical candle-power
S_h = watts per mean hemispherical candle
S_s = watts per mean spherical candle
P = renewal cost per trim or life
l = life of lamp or electrode
C_r = renewal cost per kilocandle-hour
C_t = total cost per kilocandle-hour
R = rate per kw-hour.

The lamps represented in the tables may be considered as typical or normal for the special kind of lamp in question, the data regarding quality and performance of the lamps are taken from trade and other publications and it has been endeavored to give proper values for each lamp without palliation or misrepresentation; the prices are standard or average trade prices

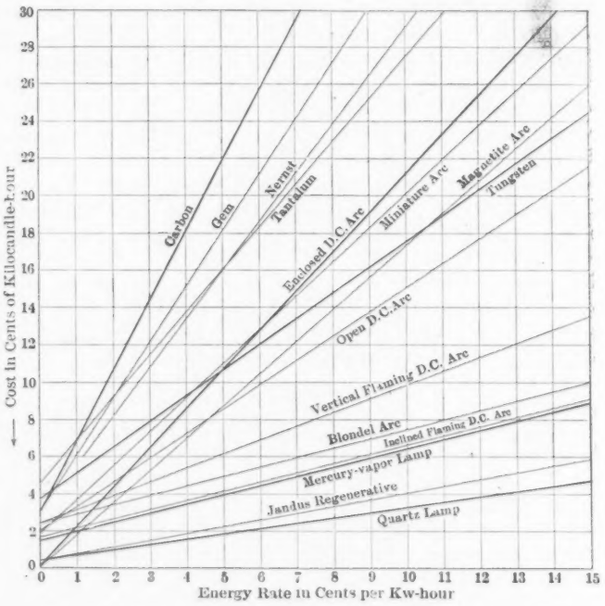


FIG. I.—COSTS OF OPERATING VARIOUS MULTIPLE LAMPS.

Some of the lamps are comparatively new to the general public, especially the mercury-vapor quartz lamp, which is a new type of lamp not yet manufactured in this country. The chamber containing the mercury is made of quartz, which has a very high melting point and considerable heat-resisting ability. For this reason, it is possible to use a much higher current temperature and vapor pressure in quartz lamps than have been customary in mercury-vapor lamps and consequently an increase of the efficiency of the lamp is obtained.

The Carbone lamp is also comparatively unknown in this country; it may be called an arc lamp with inclined normal carbon electrodes yielding a rather long arc of a sun-like color and possessing somewhat longer life than the vertical open arc carbon lamps.

Another lamp has become of interest of late which might be classified as an "enclosed flaming arc lamp." The commercial name of it is "Jandus regenerative arc lamp." It has been described recently in the English technical press. As stated there, the lamp is intended mainly for street, open space and work-shop lighting, indicating that the annoyance from fumes and gases has not yet been overcome, although its efficiency is greater and its life is considerably longer than that of the ordinary flaming arc lamp.

All the other lamps have been freely described in standard periodicals and do not require any special mention.

Table II gives the total cost of light production for different rates for energy varying from 2 to 12 cents per kw-hour, and Fig. 1 is the graphical illustration thereof.

Tables III and IV and Fig. 2 refer to series incandescent as well as arc lighting, and it will be noticed that several lamps which appear in Tables I and II are left out, as they have not been developed for series lighting. Other lamps, however, possess remarkable advantages for series operation. For instance, the tungsten lamp, when adapted to a lower voltage on series circuits, gives a stronger and more stable lamp; series operation is favorable for arc lamps, because the resistor, which consumes quite a portion of the energy, can be omitted, whereby the actual or total energy consumption of the lamp is considerably reduced.

The cost for trimming of arc lamps is of course higher for series street lighting, as the distances from lamp to lamp are greater. For instance, with 20 lamps per mile, 3 cents per lamp must be added to the cost for trimming, which will therefore amount to from 5 to 8 cents per lamp.

In general the tables are self-explanatory and do not require any further comment. The influence of the renewal cost is obvious, being comparatively small for higher energy rates, but of intrinsic significance if efficient illuminants are used at a low rate for energy.

The advantage of the mercury-vapor lamp over the flaming arc lamp is due to the low renewal cost of the former; the superiority of the tungsten lamp over the enclosed miniature arc lamp is also remarkable.

If one compares the cost of the kilocandle-hour of the old carbon incandescent lamp at a rate of 10 cents per kw-hour, namely, 40.7 cents, with the latest mercury-vapor quartz lamp, at 3.25 cents, he is in position to appreciate the progress which has been made in increasing the efficiency and decreasing the cost of light production.

TABLE I.—CHARACTERISTICS OF VARIOUS MULTIPLE ILLUMINANTS.

Illuminant.	A	V	W_t	L_h	L_s	S_h	S_s	P	l	C_r
INCANDESCENT LAMPS.										
Carbon	.31	110	50	20	13.2	2.8	3.8	16	450	2.7
Gem	.45	110	50	26.5	16.5	1.9	3.05	20	450	2.7
Meridian	2.3	110	250	130	82	1.9	3.05	70	450	1.9
Nernst	1.0	110	110	79.4	42.5	1.37	2.6	65	500	3.0
Tantalum	.36	110	40	25.5	17	1.57	2.3	50	700	4.5
Tungsten	.91	110	100	115.0	72	.87	1.4	200	800	3.6
DIRECT-CURRENT ARC LAMPS.										
Open arc	10	55	550	725	400	.76	1.3	8	10	2.0
Enclosed	5.0	110	550	435	260	1.16	2.1	9	150	.2
Carbone	10	110	1100	950	550	1.16	2.0	8	16	1.0
Miniature	2.5	110	275	220	150	1.25	1.8	6	20	2.0
Magnetite	3.5	110	385	400	225	.96	1.7	10	150	.31
Flaming	10	55	550	1200	600	.4	.75	17	10	2.4
Blondel	5	55	275	1080	550	.255	.5	25	18	2.5
Inclined flaming	10	55	550	2150	1100	.255	.5	18	10	1.6
Inclined enclosed flaming	5.5	100	550	2200	1500	.25	.365	30	70	.31
ALTERNATING-CURRENT ARC LAMPS.										
Open arc	15	—	530	470	300	1.10	1.75	10	13	2.2
Enclosed	7.5	—	600	350	230	1.7	2.6	9	100	.4
Flaming	10	—	330	750	425	.4	.8	17	7	5.6
Inclined flaming	10	—	550	1950	1000	.3	.55	18	10	1.3
Blondel	10	—	350	1400	715	.265	.5	25	15	2.3
MERCURY-VAPOR LAMPS.										
Cooper Hewitt	3.5	110	385	—	770	—	.5	1200	4000	0.4
Quartz	4.2	220	924	—	2740	—	.33	700	1000	.25

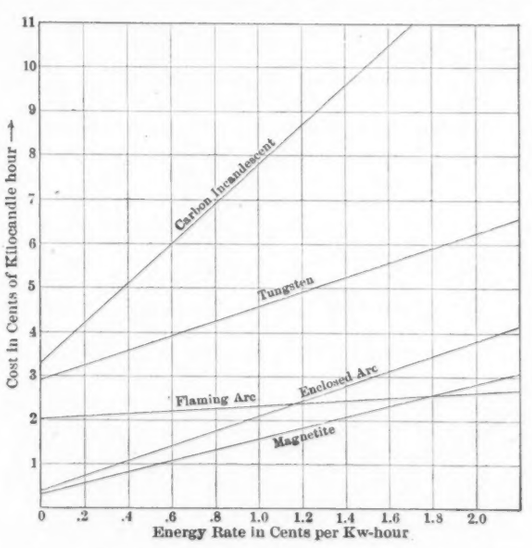


FIG. 2.—COSTS OF OPERATING VARIOUS SERIES LAMPS.

TABLE II.—ECONOMICAL ASPECT OF VARIOUS ILLUMINANTS AT DIFFERENT RATES FOR ENERGY.

Illuminants.	S_s	C_r	$C_t = S_s \times R + C_r$. Rate per kw-hour. 2	4	6	8	10	12
INCANDESCENT LAMPS. Rating.								
Carbon 16 c.p.	3.8	2.7	10.3	17.9	25.5	33.1	40.7	48.3
Gem 20 c.p.	3.05	2.7	8.8	14.9	21.0	27.1	33.2	39.3
Meridian 100 c.p.	3.05	1.9	8.0	14.1	20.2	26.3	32.4	38.5
Nernst 110 watt	2.6	3.0	8.2	13.4	18.6	23.8	29.0	43.2
Tantalum 20 c.p.	2.3	4.5	9.1	13.7	18.3	22.9	27.5	32.0
Tungsten 80 c.p.	1.4	3.6	6.4	9.2	12.0	14.8	17.6	20.4
DIRECT-CURRENT ARC LAMPS.								
Open arc 10a. 2 i. ser.	1.3	2.0	4.6	7.2	9.8	12.4	15	17.6
Enclosed 5 a. 110 v.	2.1	.2	4.4	8.6	12.8	17.0	21.2	25.4
Miniature 2.5 a. 110 v.	1.8	2.0	5.6	9.2	12.8	16.4	20.0	23.6
Carbone 10 a. 110 v.	2.0	1.0	5.0	9.0	13.0	17.0	21.0	25.0
Flaming 10 a. 2 i. ser.	.75	2.4	3.9	5.4	6.9	8.4	9.9	11.4
Blondel 5 a. 2 i. ser.	.54	2.5	3.5	4.5	5.5	6.5	7.5	8.5
Inclined Flam. 10 a. 2 i. ser.	.5	1.6	2.6	3.6	4.6	5.6	6.6	7.6
Encl. Flam. 5.5 a. 110 v.	.365	.3	1.03	1.76	2.49	3.22	3.95	4.68
Magnetite 3.5 a. 110 v.	1.7	.31	3.71	7.11	10.51	13.91	17.31	20.71
ALTERNATING-CURRENT ARC LAMPS.								
Open 15 a.	1.75	2.2	5.7	9.2	12.7	16.2	19.7	23.2
Enclosed 7.5 a.	2.6	.4	5.6	10.8	16.0	21.2	26.4	31.6
Flaming 10 a.	.8	5.6	7.2	8.8	10.4	12.0	13.6	15.2
Inclined flaming 10 a.	.55	1.8	2.9	4.0	5.1	6.2	7.3	8.4
Blondel 10 a.	.5	2.3	3.3	4.3	5.3	6.3	7.3	8.3
MERCURY-VAPOR LAMPS.								
Cooper Hewitt 3.5 a.	.5	.4	1.4	2.4	3.4	4.4	5.4	6.4
Quartz 4.2 a.	.3	.25	.85	1.45	2.05	2.65	3.25	3.85

TABLE III.—CHARACTERISTICS OF SERIES LAMPS.

Illuminant.	A	V_s	W_s	L_h	L_s	S_h	S_s	P	L	C_r
Carbon incandescent	5.5	32.0	176	50	40	3.5	4.4	.55	410	3.35
Tungsten	5.5	14.7	81	60	48	1.35	1.7	1.40	1,000	2.9
Enclosed arc	5.0	80.0	415	350	232	1.18	1.8	12.00	150	.35
Magnetite	4.0	78.0	310	429	244	.72	1.27	13.00	150	.35
Flaming arc	8.0	45.0	360	2,100	1,020	.17	.35	21.00	10	2.0

TABLE IV.—ECONOMICAL ASPECT OF VARIOUS SERIES LAMPS.

Illuminant.	A	S_s	C_r	.2	.4	.6	.8	1.	1.2	1.4	1.6	1.8	2
Carbon incandescent	5.5	4.4	3.35	4.2	5.1	6.0	6.9	7.8	8.7	9.6	10.5	11.4	12.3
Tungsten	5.5	1.7	2.9	3.24	3.58	3.92	.426	4.70	5.04	5.38	5.72	6.06	6.4
Enclosed arc	5	1.8	.35	.71	1.07	1.43	1.79	2.05	2.41	2.77	3.03	3.69	3.85
Magnetite	4	1.27	.25	.6	.85	1.1	1.25	1.62	1.85	2.1	2.35	2.72	2.89
Flaming arc	8	.35	2.0	2.01	2.14	2.21	2.28	2.35	2.42	2.49	2.56	2.63	2.7

The Series Transformer.

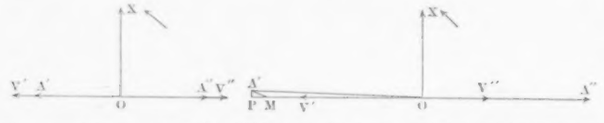
By E. S. Harrar.

THE chief function of the alternating-current series transformer is to furnish to the measuring or indicating instrument a current proportional to the line current in a certain ratio. In this respect it is analogous to the shunted resistor used to accomplish the same result in direct-current service. The actions of the two devices, however, are altogether different.

The shunted resistor merely provides a sufficient voltage to cause a small current to flow through connecting leads to the instrument, and since this voltage will increase with increase of line current, the instrument current will be proportional to the line current. If the shunt has no temperature coefficient the ratio of instrument current to line current is constant for all values of line current. It is to be noted that the connecting leads and live parts of the instrument are at the same potential as the busbar to which the shunt is connected.

The current supplied to the measuring instrument by the series transformer is also proportional to the line current, but the ratio may not be strictly constant for all values of line current. It is also a separate current from the line current, is at a different potential, and has a different phase.

In general these transformers consist of only two small coils built up with an iron core. One coil, the primary, is connected in series with one of the line wires, and the other coil, the secondary, is connected to the terminals of the instrument, thus being closed through the coils of the instrument. The coil connected in the line is necessarily at line potential, which may be thousands of volts above ground potential, hence, if this coil has sufficient insulation to prevent a break-down between coils or between primary coil and iron which is at ground potential, the secondary coil and iron and, consequently, the instrument are effectually insulated from the line potential. This feature is of great importance, as it provides a means of indicating the line current on extremely high-voltage circuits and still have the switchboard instrument at low potential. A series-switchboard instrument capable of measuring the total current at line potential would be impracticable on high-voltage circuits, for the amount of insulation required and the spacing between live



FIGS. 1 AND 2.—VECTOR DIAGRAM OF IDEAL SERIES TRANSFORMER AND TRANSFORMER UNDER NON-INDUCTIVE LOAD.

parts would make such an instrument out of proportion to other equipment and be extremely expensive as well as a source of danger.

The fundamental expression for the current of a series transformer is the same as for the shunt transformer. This expression is as follows:

$$\frac{A'}{A''} = \frac{T''}{T'} = R \text{ or } T'' = RT' \qquad (1)$$

where A' = primary amperes.
A'' = desired secondary amperes.
T' = primary turns.
T'' = secondary turns.
R = desired ratio of transformation.

That is to say, with desired ratio known and primary turns fixed, the secondary turns are equal to primary turns multiplied by the desired ratio. It must be understood that the relations expressed by the above equations are ideal and are not strictly true, but are assumed to be true for the present merely as a basis of development.

A vector representation of these ideal conditions is shown in Fig. 1 for a 1 to 1 ratio of transformation and a non-inductive secondary load.

In the above figure OX is the direction of magnetic flux.
OA' is primary current
OA'' is secondary current.
OV' is primary e.m.f.
OV'' is secondary e.m.f.

In this case the primary voltage and current are equal to and opposite in phase to the secondary voltage and current, respectively, and since the load is assumed non-inductive the secondary current is in phase with secondary voltage, and primary current is in time-phase with the primary voltage. If the ratio is other than 1-to-1, OA' and OA'' must be expressed in ampere turns and they will still be equal and opposite, the voltages in this case being no longer equal. As we are to deal with the ampere or ampere-turns relations voltage ratios will be ignored in further discussion, and OA' and OA'' will be expressed in ampere-turns, whence the vector representation will apply to all ratios.

In the actual transformer the ampere-turns necessary to supply the core loss and to overcome the reluctance of the core

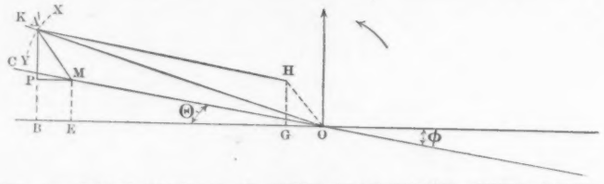


FIG. 3.—VECTOR DIAGRAM OF SERIES TRANSFORMER UNDER INDUCTIVE LOAD.

causes a change in the current relations, as is shown by Fig. 2, which is a vector representation of the actual conditions met with in practice, the core loss and reluctance being taken into consideration. A non-inductive load is again assumed.

In this case the secondary current is still in time-phase with the secondary voltage since the secondary load is non-inductive, but the primary current lags behind the primary voltage, as represented by the angle $A'OV'$. Using ampere-turns in plotting Fig. 2, OA'' is the secondary ampere-turns, and OA' is the total primary ampere-turns, being equal to the line current multiplied by the primary turns, and is made up of two components, namely, $A'M$, that part which supplies the core loss and overcomes core reluctance, and OM, that part which is equal and opposite to the secondary ampere-turns. $A'M$ may be further resolved into its two components, MP and $A'P$, the iron loss and wattless components, respectively.

Fig. 2 shows that in order to approach the ideal case, $A'M$ must be kept small, since the smaller $A'M$ is the nearer will OM, which is equal to the secondary ampere-turns, be to OA'. Since the component OM of the primary ampere-turns is always equal to the secondary ampere-turns, it is convenient to call OM the secondary ampere-turns, OA' total primary ampere-turns, and $A'M$ the magnetizing ampere-turns.

In order to keep $A'M$ small the induction at which the iron is worked must be kept low. This may be accomplished either by allowing sufficient turns of wire, or a large cross-section of iron for the particular transformer conditions. $A'M$ may be further maintained small by keeping the magnetic path as short as possible. Inspection of Fig. 2 shows that for this case (non-inductive load) the effect of the component MP is to decrease the secondary ampere-turns directly, while the effect of $A'P$ is to cause a phase difference between the primary and the secondary currents. A small increase in the value of $A'P$ will not affect the value of OM appreciably, but an increase in the value of MP affects OM directly.. In fact, if a series transformer is correctly designed for the particular service required of it, the secondary ampere-turns for non-inductive secondary load may be taken as equal to $OA' - PM$, the difference between OA' and OP being so small as to be negligible. Dividing $OA' - PM$ by the secondary turns will give the secondary amperes without appreciable error. The procedure in finding the secondary current in this case is then very simple. It is necessary merely to determine the ampere-turns, supplying the iron loss, subtract this value from the total primary ampere-turns

and divide by the secondary turns. To determine the iron-loss ampere-turns it is necessary to know the loss in watts per unit. weight of iron at given frequency and various inductions. From this the iron loss ampere-turns are found as follows:

Let W = watts iron loss at given frequency and induction.
V = volts corresponding to given induction.
A = iron loss amperes.
T'' = secondary turns across which V is measured.

Then $A = \frac{W}{V}$ and ampere-turns iron loss $= AT'' = \frac{WT''}{V}$ and on the basis above-mentioned it follows that

$$\text{Secondary ampere-turns} = A'T' - \frac{WT''}{V} \qquad (2)$$

dividing equation (2) by secondary turns

$$\text{secondary amperes} = A' \frac{T'}{T''} - \frac{W}{V} \qquad (3)$$

Equation (3) shows that if the ratio of primary to secondary turns is made equal to $\frac{I}{R}$ or $\frac{A''}{A'}$ (equation 1), the secondary current will be less than the desired value by the amount $\frac{W}{V}$ amperes. The per cent error in transformation is $\frac{100\,W}{A''\,V}$

This error can be compensated for, however, by designing the transformer as if the secondary current was to be increased by the amount $\frac{W}{V}$ amperes, and equation 1 takes the form

$$\frac{A'}{A'' + \frac{W}{V}} = \frac{T''}{T'} \text{ or } T'' = \frac{A'}{A'' + \frac{V}{W}}\, T' \qquad (4)$$

That is, the secondary turns must be slightly diminished from the ratio $\frac{A}{A''}\, T'$ in order that the secondary current shall equal A'', the desired value. If the solution of equation 4 for a particular case shows T'' to be a whole number of turns, the compensation will be exact. If, however, the value of T'' is found to contain a fraction of a turn, the nearest whole number must be used and a slight error will result.

A specific example of a particular transformer may be of interest as an illustration of the above conditions. In a certain given transformer the primary current was 200 amperes and the desired secondary current 5 amperes, whence $R = \frac{200}{5} = 40$. The number of primary turns was fixed at 8. If the secondary turns had been determined from equation (1) the value would have been 40×8 or 320. W was found to be .12 when $V =$ 3 volts. Then, according to equation (3) secondary current $= 200 \times \frac{8}{320} - \frac{.12}{3}$ or secondary current $= 5 - .04 = 4.96$ amperes and per cent error $= \frac{.04}{5} \times 100 = .8$ per cent.

Instead of making the turns equal to 320, the number was determined from equation 4 thus: $T'' = \frac{200}{5 + .04} \times 8 = \frac{1600}{5.04} =$ 317.46, and as 317 is the nearest number of whole turns T'' was made 317, whence actual secondary current $= 200 \times \frac{8}{317} - \frac{.12}{3} = 5.0073$ and per cent error $= \left(1 - \frac{40 \times 8}{317} + \frac{.12}{3 \times 5}\right) \times 100$

$= (1 - .100946 + .008)\ 100.$

$= -.146$ per cent.

That is, the error of .8 per cent has been overcompensated for, and the secondary current will be slightly high (less than 15/100 of 1 per cent) at full load. This is not a bad feature, however, for the per cent error increases with decrease of load, hence the average loss below full load will be less than if the compensation had been exact. This is readily seen to be true, for as the load decreases the voltage decreases and the induction decreases in the same proportion, but as the iron loss varies as some power of the induction greater than unity, the per cent decrease in watts loss is less than the per cent decrease in induction or in load.

It should be noted again at this point that the above development of formulas is based on the assumption that when the secondary load is non-inductive the secondary ampere-turns are equal to total primary ampere-turns minus the ampere-turns supplying the iron loss, and that this is allowable is proved by numerous tests on well-designed transformers in which the difference between the actual value and assumed value is too small to have any effect on the result. In fact, the quality of iron in any case may vary from the quality taken as standard and from which the iron losses was determined to such an

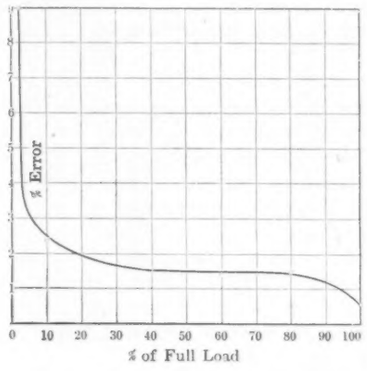


FIG. 4.—VARIATION OF ERROR WITH LOAD ON A SERIES TRANSFORMER.

extent that the loss may be greater or less than the calculated value and the error due to this may be greater than that due to the above assumption.

When the secondary load is inductive the conditions are altogether different. Fig. 3 is a vector representation of this case which shows the secondary current lagging behind the secondary voltage by the angle Θ. This causes the component OM of the primary ampere-turns to lag Θ time-degrees behind the primary voltage, and the total primary ampere-turns to lag still further behind.

In this case OM may be determined either graphically or analytically, and great care must be exercised in either method for the values of $A'P$, PM and $A'M$ are so small in proportion to OA' and OM that a serious error will result if the scale is not made large or if the calculations are not carried far enough.

The graphic solution is as follows:

The known values are Θ, $A'M$, PM, $A'P$ and OA'. Lay off $BOC = \Theta$, $OG = PM$, $GH = A'P$ and $OH = A'M$. Draw HK

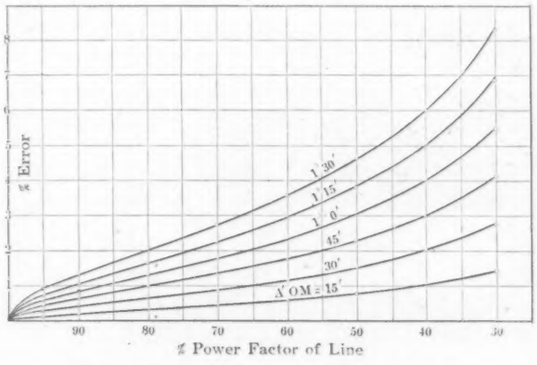


FIG. 5.—VARIATION OF ERROR WITH LOAD POWER FACTOR FOR DIFFERENT TRANSFORMER PROPORTIONS.

parallel to OC, and with O as the center and a radius equal to the primary ampere-turns describe arc $X - Y$ cutting HK at A' Construct the triangle $A'PM$ at A' with sides parallel to HGO and join OM, whence OA' = total primary ampere-turns, $A'M$ = magnetizing ampere-turns, and OM = secondary ampere-turns, whence by dividing by secondary turns the secondary amperes will be obtained.

The analytical solution is as follows: Project $A'P$ to B and draw ME perpendicular to OB.

Then $(A'P+PB)^2+(OE+BE)^2=OA''^2$ or $(A'P+OM\ sin\ \Theta)^2+(MP+OM\ cos\ \Theta)^2=OA''^2$ which reduces to $OM^2+2SOM=OA''^2-A'M^2$ where $S=(A'P\ sin\ \Theta+MP\ cos\ \Theta)$, all the terms of which are known;

$$\text{finally } OM=\pm\sqrt{OA^2-A'M^2+S^2}-S.$$

Figs. 4 and 5 are characteristic curves of these transformers, showing losses typical to this class of transformers.

Fig. 4 shows the total error introduced into the wattmeter reading by a reasonably well-designed transformer. This curve was obtained by taking readings on a standard wattmeter when connected directly to the line and again when connected through the transformer, which has a 1 to 1 ratio. In this manner the errors due both to phase displacement and to iron loss were determined.

Fig. 5 shows the errors that will be introduced into wattmeter readings due to phase displacement and has been plotted for various values of the angle *A'OM*. This figure shows that if the power factor of the line is 100 per cent, the error due to phase displacement is negligible, even for $A'OM=1°-30'$, and that as the power factor decreases the error increases, and at a more rapid rate for higher values of *A'OM*.

A'OM should never be more than 45 seconds, even if ammeters alone are to be operated from the transformer, in order that the difference between *OA'* and *OP*, Fig. 2, may not be too large and the ratio error increased accordingly.

"Over-Shooting" of Tungsten Incandescent Lamps.

By John B. Taylor.

A short article in the issue of the Electrical World for April 25 described what has been termed an "over-shooting effect" in the light from the tungsten incandescent lamp for a brief fraction of a second after the circuit is closed. The accompanying illustrations, Figs. 1 and 2, present the photographic evidence to show that this "over-shooting effect" is a real physical action as distinguished from a physiological effect or mental impression. These records were made on a photographic film 4 in. wide and a little over 12 in. long, placed in the G. E. oscillograph film holder shown in Fig. 1.

For making these records, the film drum was placed in a screw cutting lathe and driven at a uniform speed of approximately 266 r.p.m. The screw cutting gears were arranged for six threads per inch, while the tool post carried a piece of cardboard covering the slit seen in the oscillograph film holder. An opening ⅛ in. wide in the cardboard exposed a small portion of the film (about ⅛ in. x 1/16 in.) to the light of an incandescent lamp under test. For these records a 20-watt, 22-volt tungsten lamp was placed about 24 in. from the photographic film. It will be readily seen that the arrangement permitted of obtaining a photographic trace more than 20 ft. long.

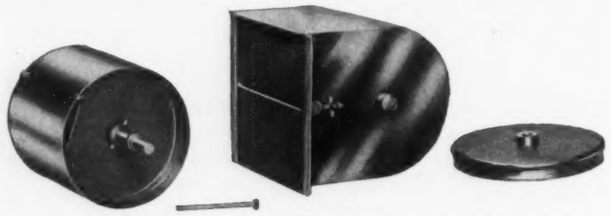


FIG. 1.—FILM HOLDER FOR PHOTOGRAPHIC ATTACHMENT OF OSCILLOGRAPH.

In Fig. 2, with the drum rotating continuously, the lamp circuit was closed at *A*, opened at *C*, closed again at *D*, etc. It is plainly evident that the trace between *A* and *B* is appreciably lighter than the remainder of the record, and the known velocity of the film gives the time between *A* and *B* as very nearly one-tenth second. Particular attention is called to the fact that this "over-shooting effect" is not seen at *D*, the lamp being still warm, as the interval between *C* and *D* is only about two-thirds second. In making this record the source of supply was a 25-volt storage battery from 15 to 20 ft. from the lamp with no inductive apparatus in the circuit.

The source of energy supply for the record of Fig. 2 was the commercial 60-cycle lighting circuit with a small auto-trans-

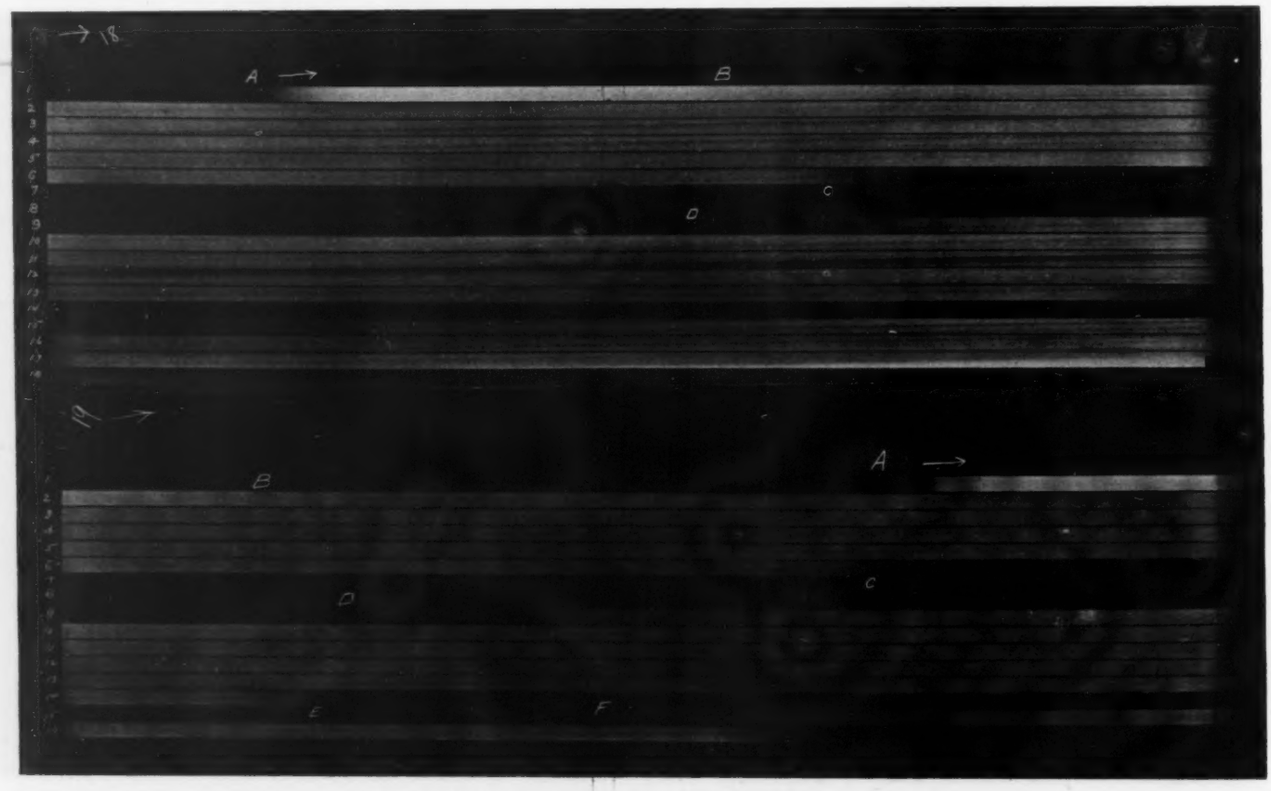


FIG. 2.—OSCILLOGRAPH RECORDS OF "OVER-SHOOTING EFFECT."

former to reduce the e.m.f. from 110 to 22 volts. The same lamp was used as for the record of Fig. 1. This record is lettered similarly to Fig. 1, the greater initial brilliancy being shown by the trace between *A* and *B*. In this record the alternate heating and cooling of the filament, corresponding to the peaks and zero values of the current wave, is readily seen.

The photographs have not been retouched. It is not claimed that the photographic trace as presented shows the proper relative values of light at the different times, as exposure and chemical development have been chosen with a view to bringing out the contrast for illustrating the phenomenon.

From the records which the writer has made, these two have been selected as best presenting the effect for reproduction. As the cause of this effect has not yet been definitely demonstrated, it seems only fair to add that a higher voltage tungsten lamp of different manufacture showed this same effect, but not in so great a degree, which might indicate that the thicker filament is in some way responsible for the effect. On the other hand, the relative exhaustion of the two lamps is not known and the relative proportions of lamp volume, surface of glass, and watts dissipated may be factors of more importance than the size and structure of the filament.

Lighting Equipment of the Union Station at Washington.

One of the most important matters that had to be dealt with in connection with the new Union Station at Washington was that of its lighting, and a number of the country's foremost illuminating and electrical engineers were engaged to give this subject close attention and study. This magnificent station has been in use since the latter part of last October, when the Baltimore & Ohio Railroad first moved into it. The electricity used in furnishing the light for the station and other buildings of the Washington Terminal Company is generated in a power house that is located some distance from the station building. The wires are carried to the various terminal buildings through a system of terra-cotta conduits located in tunnels built in the bases of the retaining walls forming the north approach to the station. To care for the wires leading to the station, 48 lines of 2-in. glazed terra-cotta ducts were laid along the wall of the 12-ft. tunnel in the west retaining wall for the wires leading to the express building; six lines of the same size ducts were laid in a 5-ft. tunnel under the north walk of H Street.

FIG. 1.—CHANDELIER USED IN DINING, LUNCH, SMOKING AND WOMEN'S ROOMS.

In the lighting of the station about 480 500-watt arc lamps, 500 high-efficiency lamps and about 3600 16-cp incandescent lamps are in service. To light the pipe and wire tunnels between the power plant and the station and the express building required 190 incandescent lamps. To care for the wires used in this great lighting system required the installation of about 83,000 ft. of conduit of various sizes, about 68,000 ft. for the express building, power plant and K Street signal tower, and about 12,000 ft. on the train sheds. In addition, about 20,000 ft. of conduits was used for the telegraph and telephone wires at the station and about 12,000 ft. at the express building, power house and K Street signal tower.

FIGS. 2 AND 3.—INTERIOR AND EXTERIOR SIDE-BRACKET FIXTURES.

Special lighting plans were necessary on account of the unusual size and height of the ceilings in the general waiting room and other rooms of the station. Natural light is provided in the general waiting room by the use of semi-circular windows located at about the elevation or spring line of the ceiling arch. In the east end of the room there is one window, on the north side five windows and in the south three windows. The west end receives light through the roof over the ticket lobby, which is equivalent to a window 50 ft. in diameter. Artificial light is furnished by 180 inverted arc lamps located in the alcoves of the balcony over the vestibules in the north and south sides of the wall.

The ticket lobby receives natural light through the roof, which is of barrel-vault design, the roof covering and ceiling being of glass construction. It was originally intended to light this space artificially and provision was made for placing 160 high-efficiency lamps in a groove or pocket in the walls of the room, located about 33 ft. above the floor. The objection to this was the inaccessibility and the fear of losing much light through the glass roof construction.

In lighting the dining room no effort was made to conceal the lamps. This room is provided with eight chandeliers (Fig. 1), each containing 12 100-watt gem lamps, and 12 side brackets, each equipped with three 100-watt gem lamps. Owing to its central location, very little natural light could be secured from the sides. To overcome this difficulty a saw-tooth roof construction was adopted, the north slope being filled with glass and the south with tile and composition roofing. To provide for additional light, should it be desired, 39 floor outlets have been installed, permitting of the placing of electric lamps on all tables.

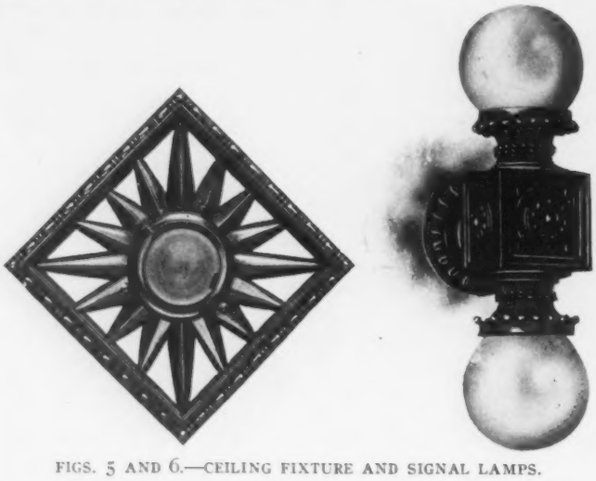
As the lunch room faces on a well-lighted concourse, and the women's waiting rooms and the men's smoking rooms front on the open portico extending across the entire front of the station, no special expedients for natural illumination were resorted to. These rooms are lighted artificially by suspended chandeliers and wall brackets. The lunch room is lighted by six chandeliers (Fig. 1) and 10 wall brackets (Fig. 2), each of the latter containing four 50-watt gem lamps. The ladies' waiting room has three similar chandeliers and nine wall brackets (Fig. 2) and the smoking room has three chandeliers and 10 wall brackets.

The baggage room is lighted by a saw-tooth roof construction, similar to that of the dining room.

FIG. 4.—DOME CEILING FIXTURE.

In the State apartments at the east end of the building there are both concealed and exposed lighting. In the reception room three handsome chandeliers are suspended from the ceiling and eight ornamental brackets are placed over the sidewalks (Fig. 2).

In lighting the open portico extending across the front of the building a distance of 620 ft., good results have been obtained by placing brackets on the faces of piers forming the north and south sides of the portico or colonnade. The same method is used in the east portico. Twenty side-bracket units are used in lighting the central pavilion or main entrance, 12 in the State entrance or east pavilion, and 36 in the west pavilion or carriage porch, making a total of 68. A view of one of these



FIGS. 5 AND 6.—CEILING FIXTURE AND SIGNAL LAMPS.

units is given in Fig. 3. Eight of the units at the main entrance are provided with six 125-watt and one 187-watt gem lamp, the other 60 are equipped with three 100-watt gem lamps. To light the remainder of the portico, 55 side brackets are used. Twenty-five of these have three 100-watt gem lamps, 30 have one 100-watt gem lamp.

In addition to the bracket lighting described, the main domes are equipped with ceiling fixtures, particularly those over the central pavilion and west carriage entrances (Fig. 4). There are three ceiling fixtures in the dome of the main portico and one in the State entrance dome, each of which is provided with six 100-watt gem lamps. Similar fixtures are used in the east and south porticos and at the carriage porch. A ceiling fixture of the same general appearance, but containing six 50-watt gem lamps, is used over the vestibule between the waiting room and the lunch room. Fig. 5 shows a form of ceiling fixture that is used over all other vestibules, about 200 being employed, each containing one 16-cp lamp.

The concourse is lighted by skylights in the roof, about one-half of the area being of glass construction, while the entire north end is open to a height of 17 ft. Artificial light is supplied by 72 arc lamps suspended from the ceiling, while 20 additional arc lamps are used in lighting the 15-ft. extension of the concourse. About 600 incandescent lamps are used in lighting the train signs, gates and train starting signals. A type of signal lamp used on gate posts at the train fence is shown in Fig. 6. It contains two 16-cp lamps. These lamps are only used when the gates are open for passengers.

The basement, where baggage and mail are handled, require the constant use of artificial light. This is supplied by 138 arc and 260 incandescent lamps. The sub-basement, used in handling of baggage to the low level, or tunnel, tracks, is lighted with 11 arc lamps.

The office space is lighted wholly by incandescent lamps distributed as follows: Mezzanine floor, 80; second floor, 690; third floor, 66, and attic, 290; on the balustrade along the east and west courts 14 arc lamps are provided.

The fixtures were manufactured by the Sterling Bronze Company, New York, the lamps being supplied by the General Electric Company. In a subsequent issue we hope to discuss the many illuminating engineering features of the building, which have been merely touched upon in the present sketch.

New Generating Station for the Delaware & Hudson Company.

An electrical generating station embodying a number of interesting features has just been completed at Mechanicsville, N. Y., for the Delaware & Hudson Company. J. G. White & Company, of New York, designed the plant and carried out the construction under the general direction of Axel Ekstrom, con-

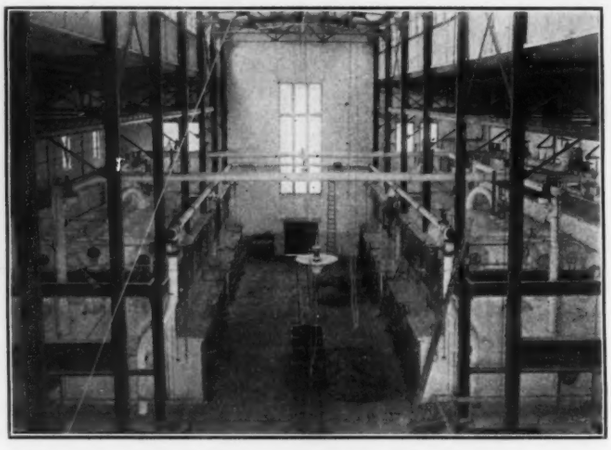


FIG. 1.—BOILER ROOM.

sulting electrical engineer of the Delaware & Hudson Company. The station is located on the west bank of the Hudson River, about one mile south of Mechanicsville and 12 miles north of Troy. The energy developed will be used for electric railway purposes by the Delaware & Hudson Company, supplementing the present sources of supply to the Hudson Valley Railway Company, United Traction Company, of Albany and Troy, and Schenectady Railway Company.

The present installation of machinery is rated at 4000 kw, but

the building has sufficient space for equipment rated at 10,000 kw and the condensing water tunnels, portions of the foundation and steel work, coal-handling apparatus and coal storage are ample for generating equipment having a 20,000-kw output.

The general arrangement of the interior of the building is novel in several respects, the principal object being to place all of the auxiliaries under the view and supervision of the engineer in the turbine room, the only auxiliaries in the boiler room being the draft blowers and engines. Economy of space, as well as suitable elevation for heaters, was secured by placing them on a platform in the turbine room parallel with the division wall.

The boiler room is 165 ft. long by 82 ft. 6 in. wide. The firing aisle parallels the turbine room and the boilers are arranged in two rows, as shown above. The dimensions of the boiler

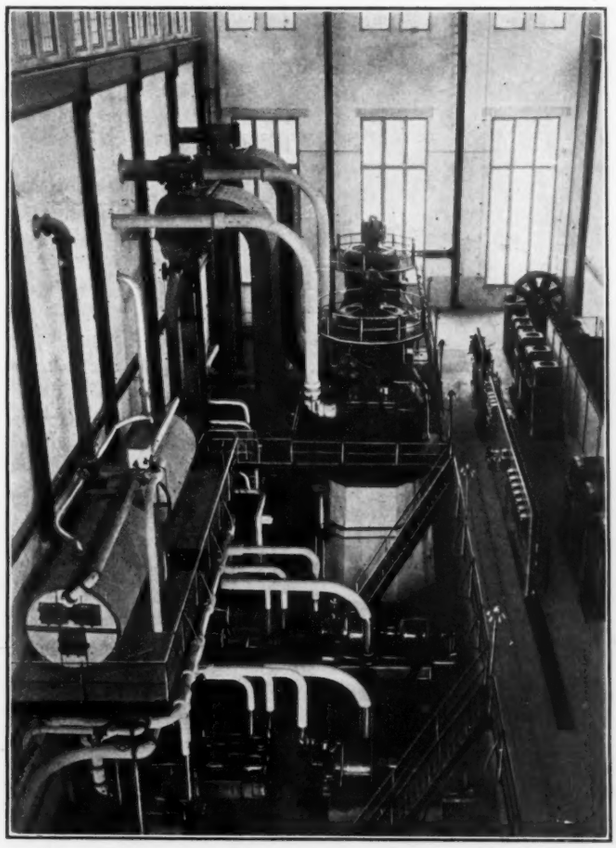


FIG. 2.—ENGINE ROOM.

room allow for an installation of 16 435-hp boilers, eight of which are installed at the present time. Below the boiler room is a basement 15 ft. 6 in. in height, the floor of which is about the level of the main turbine room floor. Besides the forced draft apparatus, the basement contains a storeroom, machine shop, oil room, locker and toilet rooms. This basement was made unusually high in order that gondola cars of the Delaware & Hudson Company could be run directly under the ash hoppers, and the ashes removed and used for ballast without making use of the station ash-handling apparatus.

The main generating room is 165 ft. long by 54 ft. wide, and is designed to accommodate two Curtis turbo-generators rated at 2000 kw and two rated at 3000 kw each. At present two 2000-kw units are installed.

The foundations for all the columns, turbines and the intake and discharge tunnels are placed on rock; all foundations and column footings are of concrete. The superstructure consists of a self-supporting steel skeleton frame, the walls of which are of brick, laid in lime and cement mortar. The two stacks are of the Custodis type, 100 ft. in height above their foundations by 9 ft. internal diameter.

The coal handling and storage arrangements for this plant are unusually comprehensive and interesting. It is the intention of the Delaware & Hudson Company, during the early spring and summer months, when there is less demand for its coal-hauling equipment than at other seasons, to accumulate coal in the storage yard adjacent to the plant. The coal-handling apparatus therefore has been designed with the idea of storing coal during these months in sufficient quantity to run the plant through the winter. The coal-storage yard is 319 ft. long by 117 ft. 6 in. wide, enclosed by retaining walls entirely spanned by a Mead-Morrison gantry crane, with a two-ton bucket capable of handling over 50 tons per hour. The approximate coal storage is 30,000 long tons.

The railroad company's coal cars are run in on a siding and directly over reinforced concrete coal pockets, under which is an industrial railroad track on the same level as the boiler-room floor. On this industrial track run charging cars, into which the coal from the concrete hoppers may be dumped and brought directly in front of the boilers. When the coal supply exceeds the requirements of the station the surplus will be permitted to flow from the pockets through gates provided on the side of each hopper into the storage yard and will be distributed by the gantry crane.

The boilers at present installed are of the Stirling type and built for a working pressure of 180 lb. per square inch. They are provided with superheaters designed to give 100 deg. superheat, and are provided with flat grates, the front and rear section of which are dumping, the remaining portions being stationary. As it is the intention of the Delaware & Hudson Company to use a low grade of anthracite bird's-eye coal, the

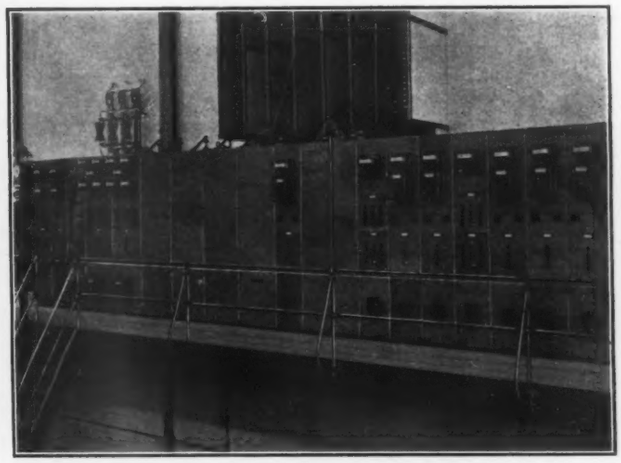


FIG. 3.—SWITCHBOARD.

ratio of grate surface to heating surface in the boilers is unusually large, approximately 1 to 30.

The boiler feed water is supplied by two horizontal duplex pumps, 14 in. x 9 in. x 12 in., so piped that either pump may supply water to any of the boilers after first passing it through the feed-water heaters. The feed water is taken from the river through the tunnel supplying water for the condensers by two 8-in. x 10¼-in. x 10-in. duplex horizontal house pumps, either of which is of sufficient size to supply the ultimate needs of the station. The two heaters are of the Cochrane horizontal type, rated at 5000 hp each.

The steam leads from the boiler are 6 in. in diameter, and connect to the main header by a system of flexible connections The main header is 10 in. nominal diameter and from it 8-in. branch leads are run to the turbines. The auxiliary steam piping is taken from the bottom of the main 10-in. steam header and this auxiliary steam main in turn is drained directly to the boiler feed pumps, this method of draining obviating the use of traps. All the steam piping is covered with two layers of 85 per cent magnesia covering, while the exhaust and feed-water piping is covered with a single thickness of similar material.

The turbine units, manufactured by the General Electric Company, are of the four-stage Curtis type, with six-pole generators, operating at 800 revolutions, and deliver current at 2300 volts and 40 cycles.

The condensers are of the Worthington barometric type; the circulating water is furnished by 14-in. steam-driven centrifugal pumps; the dry-vacuum pumps are of the rotative, single-stage type, also steam driven. The vacuum exhaust, taken from the turbine base, is carried in a rectangular steel duct, 2 ft. x 7 ft. 9 in., to the top of the condensing cone. By placing the relief valve on top of the condensing cone, the usual separate free exhaust line is eliminated. Duplicate exciter turbines rated at 75 kw each are of the Curtis horizontal, two-stage, non-condensing type, driving 125-volt direct-current generators.

The main oil switches for controlling the electrical operation of the station are the General Electric Company's type H-3. Current at 2300 volts is delivered by the turbo-generators to the busbars and thence to step-up transformers, which raise the voltage to 11,500 or 23,000 volts. The current capacity of all high-tension conductors is such as to allow full rated station output to be delivered at 11,500 volts, while the insulation and spacing are arranged for 23,000 volts. It is, therefore, possible, by means of the duplicate sets of busbars and sectionalizing switches provided, to supply electrical energy at the above voltages to outgoing feeders.

In addition to the foregoing alternating-current apparatus, there has been installed one 600-kw rotary converter for supplying direct-current to the trolley lines adjacent to Mechanicsville. Sufficient space has been provided for an additional rotary of similar size.

FIG. 4.—COAL YARD AND GANTRY CRANE.

Directly behind and over the switchboard gallery are located high-tension lightning arresters, of the multiplex type, designed for 23,000 volts, with means of reducing the number of air-gap units for use on 11,500-volt service. The main busbars of the station are in the basement directly underneath the oil switches. Paralleling the busbar compartments is the duct for supplying air to the various transformers which are located in a row, about the middle of the switchboard gallery, where they may be readily handled by the overhead traveling crane.

Roentgen Rays.

The *Philosophical Magazine* for April publishes an account of an experimental investigation by Mr. H. A. Brumstead of the heating effects produced by Roentgen rays in lead and zinc. The result previously obtained by the writer that the heat generated in lead by Roentgen rays is twice that in zinc is not confirmed by further experiments, which show that the quantities of heat are equal, with an uncertainty of from 5 to 10 per cent. No rays capable of producing scintillations on a zinc blende screen are present among the secondary radiations from lead when exposed to Roentgen rays. The disintegration of the active deposit from thorium emanation is not hastened by exposure to Roentgen rays.

Technical Welfare Work.

By Sydney Whitmore Ashe.

Much has been published concerning the proper training of the technical student while in college; and also his subsequent training in the apprenticeship courses offered by several of the large manufacturing companies. It is the purpose of this article to consider the more general problem of raising the technical status of the employee who has not been so fortunate as to obtain a college training. The ages of the latter men vary between wide limits, from 16 years to fully 60 years. Their knowledge of theory and of practical things is varied. Some have accumulated an extensive knowledge of facts and operating details, and have taken advantage of evening courses in technical institutions, while others have not been theoretically inclined, and have simply become familiar with their daily routine work. For several years past it has been the privilege of the writer to make a close study of this problem. Certain recommendations in this connection have been made to some of the large companies in New York City. These recommendations have been put into effect during the past two years by the New York Edison Company and the Edison Illuminating Company of Brooklyn. The results obtained have been very gratifying. With a hope that other companies may undertake similar work and so benefit some of their ambitious employees, the general details of this work are given.

In certain respects most practical men are similar; their knowledge of mathematics is limited to that obtained in the elementary school, their knowledge of physics and chemistry is vague, their knowledge, in fact, of all technical subjects is not very extensive. On the other hand, they possess valuable knowledge of commercial methods, and they have personal characteristics which are highly commendable. They are anxious to learn, are attentive, are not wrapped up with a sense of their own importance, can be appealed to by experimental demonstrations during a lecture, or by practical experimental work in which they take part. In laying out an educational course for practical men these factors must be borne constantly in mind.

The general scheme followed by the writer has been to prepare a course of 20 experimental lectures on electrical engineering, extending from the elements of magnetism to the subject of alternating current measurements. The topics of these lectures were as follows: 1, Magnetism; 2, electromagnetism: 3, batteries, primary and secondary; 4, electromagnetic induction. Theory of the dynamo; 5, electrolysis and electrolytic corrosion; 6, practical management of shunt motors; 7, practical management of series motors; 8, Ohm's law applied to distribution problems. The three-wire system; 9, Ohm's law applied to electrical measurements. Ammeter and voltmeter methods; 10, Ohm's law applied to electrical measurements. Galvanometer methods; 11, physics of light; 12, the carbon arc and arc lamp mechanisms; 13, incandescent lamps; 14, principles of recording wattmeters; 15, elementary principles of alternating currents; 16, alternating currents continued; 17, transformers; 18, alternating-current motors; 19, rotary converters; 20, alternating-current measurements.

The lectures were given at weekly intervals, and were about 1½ hours in length. With the New York Edison Company it was felt desirable to give an afternoon lecture as well as an evening lecture, so as to afford all employees an equal opportunity to attend. Privilege of attendance at the afternoon lectures was also extended by the New York Edison Company to the employees of other companies in the vicinity. The attendance at the evening lectures was so great at first that the seating capacity of the lecture room was taxed to its utmost, and consequently the attendance of other than employees was allowed at only the afternoon lectures.

In giving experimental lectures it is especially desirable to perform all of the experiments on a large scale so that all may see. Images of ammeters, voltmeters, galvanometers, electrolytic tanks containing liquids, small parts of instruments,

magnetic fields and diagrams should be projected on the screen so that all present will have no difficulty in following the theory as presented. This method of presentation tends to stimulate interest, and is followed to-day in many of our technical institutions. The more the spectator takes part in the lecture, such as noting instrument readings on the screen, and following calculations on the board, the greater his interest will be.

The experimental lantern should be not more than 15 ft. from the screen and the lecture table, so that no time will be lost in passing to and from the table. The lecture table should be provided with direct and alternating-current outlets, and it should also have a gas outlet. Running water should be within easy access.

In order that the greatest benefit may be obtained from such a lecture course, it is recommended that a syllabus be prepared giving dates, topics, detailed notes on experiments to be performed, and also directions for study. One of these syllabuses should be sent to every employee in the company at the beginning of the lecture course. In order to call attention to the lecture course from week to week, it is recommended that typewritten notices be posted on the bulletin boards in the offices, stations and shops throughout the company. The details in connection with these bulletins should be looked after by a special lecture committee appointed from the company's staff. These bulletins should give detailed directions for study, and should in addition show the application of the lecturers to the company's business.

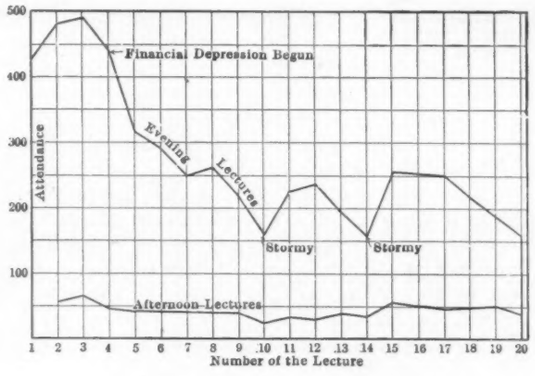
The lecturer should be primarily a teacher, who realizes the limitations of his audience, and who is familiar with practical operating methods. He should be in sympathy with his audience or he will not be successful. Much depends upon the personality of the lecturer. The men should be encouraged to come forward after the lecture, examine the apparatus and ask questions. If it is possible to supplment the original lecture course by a course of talks given by the various department heads, still better results could be obtained. For instance, a lecture given on the watt-hour meter should be followed by an operating lecture by the head of the meter department. In a similar manner, other talks could be given on storage batteries, transformers, rotary converters, etc., by the heads of the respective departments. These lectures would not only be valuable to the men, but the experience of lecturing would be excellent for the departmental heads. A better method than this, however, would be to combine the talk and the lecture, in which case the departmental head could discuss the operating features in the last 15 minutes of the lecture.

Several standard books should be selected by the lecturer and referred to from time to time during the lecture course, so as to cause individual study and self-development on the part of the men. An excellent plan was followed by the New York Edison Company of purchasing several sets of the books recommended for its lecture course, and placing these books in the library where they could be consulted by those who could not afford to purchase them, and by those who found it convenient to come early to study before the lecture. These books were referred to many times when discussions were under way, and the statements of authors were used as arguments by the discussers.

The question naturally arises as to how far this educational scheme could be carried and what would be the final result. The writer is not in a position as yet to lay out the whole of this educational scheme. Each step must be taken slowly. When a certain lecture course has been given for one year, the question naturally arises as to whether it should be repeated during a second year, or whether an advanced course should be given. If the same course be given the attendance will fall for obvious reasons, and if the course be advanced the attendance will fall because it will be necessary to use more mathematics and many men unable to follow the treatment will lose interest. The following extract from the report of the writer to the New York Edison Company with regard to another season's work will show what plans have been suggested to meet this condition:

"*Suggestions for Another Season.*—In continuing this educational work during another season the writer would recommend under no consideration to repeat the same lecture course given this year. Modifications of experiments and lectures might be used, but there must be no semblance to last year's course. The idea must be conveyed in another course that there is the element of progress present, otherwise a course, no matter how good, would lose its main purpose and the attendance would not be satisfactory. If possible, it would be wise to shift the scene of interest, in which case we should retain the interest we now have and attract other men. This would be possible in putting into effect a suggestion which has been made by the writer that a laboratory course be given to the men during another year. I cannot too highly recommend this idea, providing a way can be found for carrying on the work in an economical manner.

"There is nothing in my mind which will do so much for a man as giving to him experimental work in which he performs the part of the experimenter. The instruction in this event becomes more individual, but the initial expense per man rises. The men become immediately more productive, and their sphere of usefulness increases. They are able to do more things. They are better able to locate trouble. Their interest in their work increases and the value of the instruction to them is much increased. I see no reason why a course could not be arranged, using the company's apparatus, employing some of the company's men as assistants, which would be equal to that given in any technical institution. As it would be impossible to accommodate everyone who might apply for a laboratory course, it would seem fitting that such a course should be supplemented by an experimental lecture course. Therefore, a combination of the two would be advantageous, as well as profitable and desirable.



ATTENDANCE CURVE OF LECTURES.

"Bearing in mind the previous remarks in reference to lectures for another year, it would seem that the proper method of procedure would be to select for lectures either different pieces of apparatus of the company and to discuss their operating features in an experimental way, or to consider certain operating phases, such as voltage regulation, locating trouble, protection, what it is possible to do with a certain piece of apparatus, factors of safety, etc., and devote the lectures to them.

"There are other minor improvements which could be made during another year. For instance, wherever possible, direct application of theory to the company's apparatus or system should be made, by slides showing the apparatus or detail of the apparatus as installed. Standard wiring diagrams in elementary form, linking together the different pieces of apparatus could be manifolded and distributed to the men. Also standard formulas and data pertaining to the company's apparatus could be arranged in a similar manner and distributed to the men. Such diagrams as would ordinarily be drawn on a blackboard during a lecture could be drawn with india ink on glass and their images projected on the screen so that they could be seen by all. It would be an easy matter to exhibit with each lecture from 15 to 20 slides of different types of company's

installations and methods of construction which would be of great interest to the men.

"In laying out plans for future educational work, it would seem wise to develop the men in their weakest point, namely, the subject of mathematics. During the past winter this seemed to be the only phase of the subject which the men had difficulty in following. A simple course in practical mathematics could be given to the men at small expense. This course, however, would have to be laid out with a view to treating of only those parts of the subject of mathematics which the men would have occasion to use. For instance, in algebra through simple equations; in trigonometry, the properties of the right triangle; in analytical geometry, plotting of curves and their analysis, etc. This class need not necessarily be large, but I feel that it would fill a long-felt want."

Attendance.—The attendance at experimental lectures will be large at first, as many attend through curiosity. It will increase for the first few lectures and will then decrease slowly till a point is reached where the attendance will fluctuate until the end of the course. Curve sheet Fig. 2 shows the attendance during afternoon and evening at the New York Edison lectures. The effects of the financial condition of the country and also the effects of stormy weather are clearly shown in the curves. The following details, taken from the report on this attendance, made by the writer to the New York Edison Company, may be interesting:

"The attendance at the lectures was exceptionally large at first, due to the fact that the manner of presentation was novel and that from the experimental demonstrations it was possible to follow easily the theory as presented. This attendance, about 420 men, at evening lectures, was maintained for four weeks until the financial crisis came with its disorganizing influence, the attendance falling to 275 men. From this point the attendance followed the natural decline of all educational courses, until the alternating-current lectures were given. Here it seemed as if a process of selection had been going on, for the attendance gradually rose for a few lectures, and then declined until the 20th lecture, when the attendance was 119. At the five lectures, which were repeated for those who wished to review the subject, the average attendance was not very great, being for the evening lectures 74. The attendance at the afternoon lectures was more nearly constant, as may be noted from the attendance curve. For instance, at the 15th lecture the attendance was greater than at the first lecture, and for the first nine lectures the attendance was quite constant.

"The writer wishes to call attention to the total attendance of the course, namely, 5956 men. This result, considering the restless winter through which the course has passed, is very gratifying, and shows that great interest has been manifested in the work, an interest, judging by the number who attended regularly, which was sustained." The maximum attendance at the evening lectures was 425 men, the minimum for the original course of 20 lectures, 156; and the average, 274 men.

Interest Manifested.—The interest manifested by the men in the lecture course may perhaps best be given by extracting again from the report presented by the writer to the New York Edison Company:

"During the entire lecture course the interest manifested by the men in the individual lectures was excellent. The experiments, the slides, the tabulated information on the company's apparatus, the diagrams, the explanations, seemed to appeal to the men. After each lecture the men would come together in groups around the room, or near the lecture table, discussing the various points of interest. This discussion I understand was not alone confined to the lecture room, but was continued in the offices and stations throughout the company until the next lecture. The lectures in this way seemed to stimulate the men, creating a very healthy interest. A social spirit also prevailed at the lectures, the men looking forward to them as a time when they would meet their fellow employees. This spirit manifested itself primarily before the lectures when the men would meet in the library and smoke.

"From time to time the writer received inquiries from the men regarding other evening studies at Cooper Union, Columbia University and the Brooklyn Polytechnic Institute. During the winter, four of the Edison employees took up laboratory work at the Brooklyn Polytechnic as a result of the lectures, and several others have expressed an intention of doing likewise next year. Quite a few others intend to join the American Institute of Electrical Engineers. Several regulator attendants have come together at stated intervals to discuss questions which have arisen, and they are endeavoring to form a society. The writer has encouraged this interest, as it is realized that it is good to accustom the men to coming out during evenings or afternoons for self-study.

"There is no natural inclination on the part of men to educate themselves, so that all educational courses represent up-hill work. Self-development of the men was the keynote of the New York Edison course, and therefore anything which it was within the power of the writer to do to stimulate the enthusiasm of the men in this direction, was done."

It will be readily seen from the foregoing remarks that much can be done to raise the educational status of the employee.

If this system of education be continued for a few years it would be possible by a process of concentration on fundamental principles, of using practical mathematics, of dwelling upon a company's methods to develop valuable, practical, operating engineers from among the employees of the company.

In closing it might be well to mention the plans which have just been consummated by the Brooklyn Edison Company for next year, its third year of educational work. A course of 20 experimental lectures will be given dealing with the Edison System from "The Coal Pile to the Consumer." From the two years' previous experience at the lectures, the men are now in a position to discuss operating features and understand the relation of the fundamental principles to them. In the last 15 minutes of each lecture a department head will take charge and discuss such operating features as had not been previously mentioned in the lecture. Excellent results are expected from this method. The writer will have charge of this course.

Remote Controlled Valves in Power Stations.

A reliable device for closing steam valves from a remote point will in many cases be found of considerable value. Such a device, however, should be positive in operation, and the closing should be effected gradually, as a sudden closing would throw considerable strain on the steam-piping. A number of constructions are on the market, more or less fulfilling these requirements. The device described below, which is applicable for quite a number of other conditions, has been developed for the special purpose of closing from remote points high-pressure gate valves in the steam mains of the two turbo-generator power stations of the New York Central Railroad Company, New York. The arrangement consists of a 14-in. gate valve, actuated by a hydraulic cylinder of standard construction available on the market. The gate valve is operated by a four-way pilot valve, admitting water supplied either from the city water mains or from the boiler feed pumps, above or below the hydraulic piston.

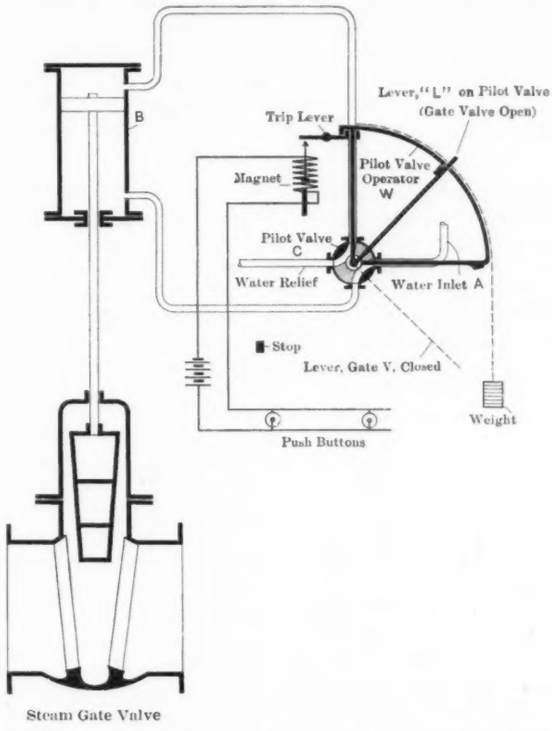
As shown in the illustration, water enters at *A*, moving the piston in the hydraulic cylinder *B* up or down, according to the position of the four-way pilot valve. To the pilot valve is connected a lever *L*, which is turned 90 deg. by the pilot valve operator *W*, when the latter is released by the tripping magnet in case contact is made by a push button. Energy can be obtained from a storage battery, or from any lighting circuit.

It will be noted from the sketch that lost motion is allowed between moving parts in order to safely overcome friction that might otherwise cause sticking of the tripping device or pilot valve. The entire construction is enclosed in a tight cast-iron case, and an indicator shows whether the valve is open or closed. The valve, after it has been tripped, can be reset by a removable handle.

The advantages of the above construction are the following:

The valve can be closed from any point in the power station; for instance, from the switchboard gallery. It can either be used to shut off the steam supply from the engines or turbines in case of emergency, or regularly as soon as the electric load is taken off and the machine is to be shut down. The valve cannot be opened accidentally, because the counterweight has to be reset, making it necessary for a man to go to the valve for opening it. The valve can, however, be opened as readily as any ordinary valve, hydraulically operated, not equipped with the special electrical tripping device. The time of closing the valve can be adjusted by properly limiting the water supply, making its performance independent from the operator, and permitting the valve to be closed sufficiently slow to avoid excessive strain on the piping. The mechanism is simple and positive, and it is not apt to get out of order, an advantage over most motor-operated valves. Long and cumbersome water connections are not required as in case of exclusively hydraulic operation.

It should be mentioned that all wiring must be installed most carefully, in order to preclude a possibility of accidentally tripping a valve, or failure to operate in case of emergency. With such a device in the hands of a switchboard operator, giving him control of the steam supply to the engine, it is believed that the safety of operating large power stations can be increased. There should be no hesitancy in giving the switchboard operator control over the valves in the steam mains to steam-driven generators, for the reason that the steam supply can be shut off as soon as the generator is taken off the system. In case of emergency, for instance, burnout of a generator,



TRIPPING ARRANGEMENT FOR HYDRAULICALLY OPERATED VALVE.

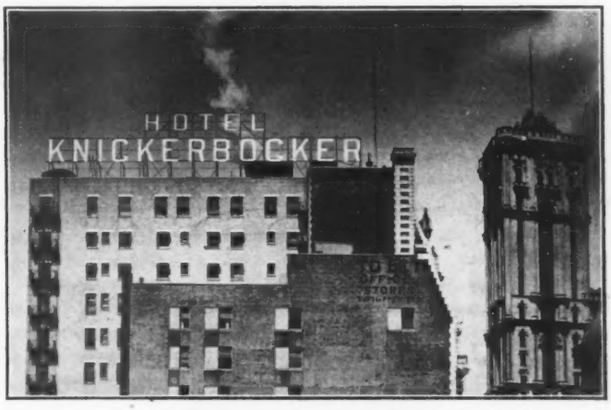
the main circuit breaker will trip automatically, and under these conditions, the possibility of shutting off the steam supply from the switchboard gallery will tend to decrease the accident and danger to the operating force; also, avoid confusion in the engine room.

Wireless Telephony.

A note on a patent of A. Steinacker and A. Plisnier describing some improvements in wireless telephony is published in London *Electrical Engineering*. It is stated that good results have been obtained by substituting a mercury-vapor lamp for the copper-carbon arc in the oscillating circuit.

Large Hotel Sign on Broadway, New York.

There has just been erected on the roof of the Hotel Knickerbocker, at the corner of Broadway and Forty-second Street, New York, one of the largest electric signs on the Rialto. The sign is 105 ft. long and 27 ft. high and faces toward the Grand Central Depot. On it are the words "Hotel Knickerbocker" forming two lines. The letters in the word "hotel" are 6 ft. high, while those in the word "Knickerbocker" are 8 ft. high. The framework is constructed of angle iron throughout and is riveted and bolted. Before being assembled and fastened to



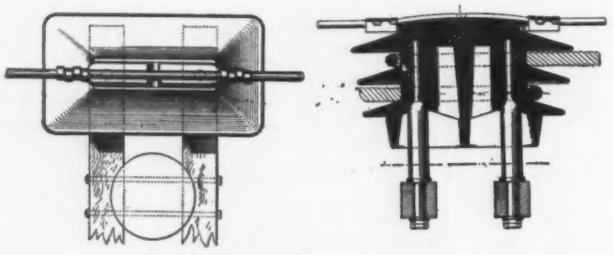
ELECTRIC SIGN ON HOTEL KNICKERBOCKER.

the roof all the iron work was painted with red lead. The framework is thoroughly braced and fastened to the roof of the hotel with lead expanders, which seal the bolts and thus prevent rust and deterioration. About five tons of iron were used in the skeleton framework and the factor of safety is very high. The wind pressure of the average storm at Times Square was determined and the framework designed to withstand a storm five times as great, so that it is doubtful if even a cyclone would cause it to show the slightest sign of weakening. The letters in the sign are an improvement over the old-style skeleton letter heretofore used on signs of this type. The receptacles which heretofore were exposed are in the sign under discussion enclosed at the back by a gutter, so that whereas the wires in the older type of construction would break close to the terminal owing to constant vibration, in the improved type of construction these troubles are eliminated. Moreover, by this means the letter is stiffened considerably, the gutter acting as a reinforcement. There are over 400 4-cp lamps used on the sign; what is termed a 9-lamp letter being used in the upper row and a 12-lamp in the lower row; that is, there are nine and 12 lamps used in the letter "I" which is the standard used in spacing the lamps. The sign, which was built by the George H. Rice Company, of Brooklyn, is supplied with electricity from the magnificent Sprague plant installed in the basement of the hotel. Owing to its great height above the sidewalk and the absence of tall buildings between the hotel and the Grand Central Depot, the sign is distinctly visible from that distance, being silhouetted against a black sky.

Insulator for Heavy Conductors.

The accompanying illustrations show an insulator for heavy conductors, for which a patent was granted to Mr. Louis Steinberger, on April 21. The insulator body is provided with several hoods of different sizes, the largest being at the top and the smallest at the bottom, as shown in Fig. 2. The insulator body is hollow and is provided with a web crossed by other webs integral therewith. These webs serve as braces and prevent crushing of the insulator in case it is subjected to excessive strains. The inventor claims for the insulator the following advantageous features: A firm and substantial support for sustaining the insulator so as to distribute the mechanical strains upon

it; a maximum of insulating effect with a minimum of weight and a minimum of material employed in construction; the insulator may be readily removed from its support; it provides an improved means for holding the wire upon the insulator; it provides specially arranged spaces for receiving cables or other flexible members which may pull sidewise upon the insulator; it enables lighter supporting members to be used by multiplying the number thereof; it facilitates the ease with which a wire or cable may be applied to or removed from the insulator; it possesses improved means for preventing undue movement of the wire or cable relatively to the insulator; it gives each wire or cable a comparatively long stretch of surface upon which to rest, and provides internal braces for the insulator so as to reduce the weight without proportionately reducing the strength thereof, and it affords greater security and better facilities for the lineman when placing the insulators and cables into operative positions, repairing them, or removing them from the poles.

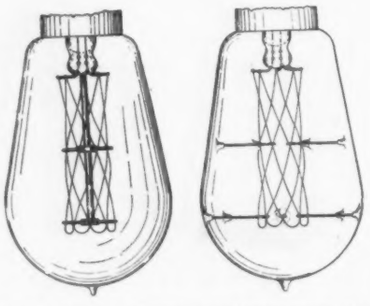


FIGS. 1 AND 2.—STEINBERGER INSULATOR.

Recent Lamp Patents.

METALLIC-FILAMENT LAMPS.

A disadvantage encountered in electric lamps of the metallic-filament type resides in the extreme fineness of the filament, which renders them liable to breakage. Mr. Hans Kuzel, of Baden, Austria-Hungary, on May 5 obtained a United States patent for a method of supporting the filaments so as to eliminate the liability to breakage, and to prevent such deformation of the loops of the filaments when hot as to cause short-circuits. The filaments are supported from a central stem or from the walls of the bulb by eyelets which are so arranged that the filaments are wound helically. The constructions are illustrated in Figs. 1 and 2.

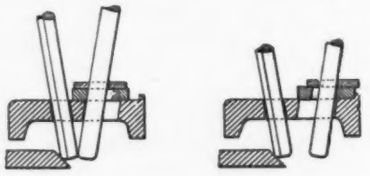


FIGS. 1 AND 2.—KUZEL INCANDESCENT LAMP.

ARC LAMPS.

In the practical operation of arc lamps with inclined electrodes fed forward by gravity, it has been found that when the aperture in the framework through which the free electrode is adapted to pass is not well sealed, the products of combustion arising from the burning electrodes and the dust will pass upward through this aperture and will injuriously affect the mechanism above it. If a single seal plate is employed as has been attempted, and this plate is large enough in its lateral movement to seal the aperture necessary to accommodate the electrode, it is apt to touch the other electrode with disastrous results. Figs. 3 and 4 illustrate a device patented by Mr. Heinrich Beck, of Frankfort-on-the-Main, Germany, on April 28, which is claimed to overcome the above difficulties. The inventor employs several superimposed apertured plates arranged to slide one above the other, each plate encircling the electrode, the lowermost one having a large opening and the plates above having progressively diminishing openings, so that each plate is adapted to seal a portion of the aperture in the surface beneath it, and the lowermost plate is adapted to seal the outer portion of the aperture in the framework and at the same time is not wide enough when the electrode is nearest to the supported electrode to contact with the supported electrode.

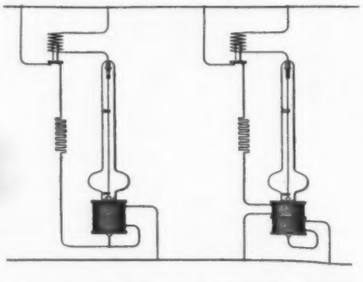
Mr. W. S. Weedon, of Schenectady, N. Y., obtained a patent on April 7 for a method of overcoming the injurious oxidation of impregnated-carbon electrodes in arc lamps. An electrode composed principally of titanium carbide possesses excellent light-giving qualities, but the high temperature at which the arc operates causes a considerable portion of the carbid to be converted into titanium oxide without vaporization. In order to prevent the oxidation, the inventor incases the titanium carbid in a sheathing of copper applied by electro-deposition. The copper and copper oxide, into which more or less of the copper adjacent the arc end of the electrode is converted, vaporize only near the arc, and until vaporized they act to protect the core so that the only consumption of the titanium carbid which takes place is at the surface from which the arcing occurs.



FIGS. 3 AND 4.—BECK ARC LAMP.

VAPOR LAMPS.

Figs. 5 and 6 show forms of an improved starting device for mercury-vapor lamps patented April 28 by Dr. C. P. Steinmetz. Under starting conditions a carbon filament extends from the upper electrode to an iron cup filled with mercury floating upon the lower mercury electrode. When the main switch is closed current passes along the filament between the two electrodes. The solenoid acting magnetically upon the iron cup draws it downward and starts an arc between the lower end of the filament and the mercury. Current will now pass through the ionized mercury-vapor directly from one electrode to the other, and almost none will exist in the high-resistance filament. The present invention relates to the circuit shown in parallel with the lamp, which is arranged to allow sufficient current to pass to the solenoid to cause the iron cup to be attracted, the current through the high-resistance filament being too weak for this purpose. When the mercury-vapor becomes ionized and the current through the lamp increases, a switch in the auxiliary shunt circuit is opened and waste of energy is prevented thereby.



FIGS. 5 AND 6.—STEINMETZ MERCURY-VAPOR LAMP.

In order to overcome the color defects of the light from a mercury-vapor lamp, Mr. Richard Kneck, of Hanaw, Germany, according to a United States patent issued May 5, would mix

other substances with the mercury. For instance, a mixture of 98 parts of cadmium with 2 parts of mercury has been found to give excellent results. When this mixture is used only a very insignificant quantity of mercury appears at every moment on the surface of the melted alloy and vaporizes, while at the same time a larger quantity of cadmium vaporizes. It is stated that even better results can be obtained by diluting the two metals to be vaporized in a metal which cannot vaporize at the operating temperature of the lamp. A suitable lamp can be made by using tin to which 5 per cent of cadmium and 2 per cent of mercury have been added. This lamp can be started by means of sparks produced by induction and it produces a light, of which the spectra of the cadmium and of the mercury show an approximately equal intensity. The tin does not boil at a temperature of 1200 deg. C. in vacuum, while the cadmium boils at 450 deg., and the mercury at 150 deg. In consequence of this no spectrum of the tin will appear, since the mean temperature of the lamp space is far below the boiling point of the tin in vacuum. In such a lamp the tin merely serves as a diluter of the two metals to be vaporized, namely, cadmium and mercury, and the effect of this diluter is that the two metals vaporize in a constant proportion on the surface of the electrode. The lamp tube should be made of quartz, so that full advantage may be taken of operation at high temperature.

LETTERS TO THE EDITORS.

The Inventor's Problem.

To the Editors of Electrical World:

SIRS:—The United States patent system purports to be a method of rewarding inventors, and thereby stimulating the production of inventions of value to the public.

In reality the principal beneficiaries of the United States patent system are the patent lawyers and the large manufacturing corporations.

There is no class of brain workers in the world so dependent upon another class as are the United States inventors upon the United States patent lawyers.

There is probably not an experienced inventor in the United States who would not prefer some one of the foreign patent systems to our patent system, unless he is really a representative of one of the large corporate interests. On the contrary, practically all patent lawyers will tell you that the United States patent system is the best in the world. And so it is for the patent lawyers. But it is probably the worst in the world for the inventor.

Our present patent system has been gradually evolved into its present form, not in the interests of the inventors nor of the public, but in the interests of the patent lawyers and of the large corporate interests. This is a natural consequence of the fact that they are the only parties who have given serious attention to changes in the patent system. The inventors seem to have foolishly hoped that someone else would guard their interests for them and they can blame no one but themselves for their present weak position.

If all the inventors of the country should elect representatives and all the patent lawyers should do likewise, and these representatives should convene to consider reforms in the patent system, it would probably be found that many radical changes advocated by the inventors would be opposed by the patent lawyers, and vice versa.

As a class the American inventors are a most helpless class, and are growing more so every day. They do not come in contact with each other and have no representative organization. The quality of American patented inventions is depreciating steadily. This is the natural result of the fact that the inventor cannot get the reward which, as a patentee, he is entitled to. Most of the money he can earn has to be spent in lawyers' services and the enormous expenses of patent interferences and litigations, and meantime the large corporations continue to appropriate his new inventions as fast as he patents them. The non-technical and inexperienced judges usually fail to see the invention which the Patent Office saw, and hence decline to grant preliminary injunctions.

The chief sufferer from all this is the American public, which in late years is surprised to find that to buy the latest and best inventions, it must indirectly pay tribute to foreign inventors, because the American inventors are being left so far behind.

Where did the inventions found in the modern automobile come from? Europe.

Where did the designs of our best battleships come from? Europe.

Where did the inventions as to recent electric-railway development come from? Europe.

Where did the revolutionary inventions in high-efficiency incandescent and arc lamps come from? Europe.

It is unnecessary to extend the list. Every observer knows that while 20 years ago we heard almost daily of important inventions of American inventors, nowadays we are obliged to talk of the inventors of the past generation in this country.

What will be the outcome of this suppression of the constitutional rights of American inventors? Probably the outcome will be still further combinations of capital and new boards of patent control and further increase in the price to the public of every manufactured article.

What is the relief for the public and for the inventor? The abolition of the so-called patent rights or else an intelligent revision of the laws by Congress in the interests of the public and of the inventors.

The interests of the public and those of the inventor are in common. The interests of the large corporations and of the patent lawyers are certainly not usually in common with those of the public and the inventors.

It is to the interest of the public and of the inventor that the inventor should have for the life of his patent the maximum protection at the minimum cost to him, because this enables the inventor to make new inventions, to the ultimate benefit of the public and of the inventor. The corporate monopolies rely upon capital and organization more than upon inventions, and it is to their interest that the unaided inventor should have the minimum protection and should have the maximum expense in trying to establish his rights. As to the patent lawyer, he is the chief beneficiary of the minimum protection and maximum expense system.

Every real inventor would gladly pay to the government 10 times the present patent fees if the government would stop granting improper patents upon unpatentable devices, and, on the other hand, would carry out its agreement with him in good faith whenever he is really entitled to a patent.

If the government cannot afford to guarantee at its present small fee the exclusive right it purports to grant, and gets paid for, why does it not charge the inventor enough to do its work properly and guarantee its grants in good faith?

It is to be expected that the majority of the patent lawyers and the large corporations would oppose the idea of increasing the government fee to an amount such as would enable the government to really guarantee to the inventor the exclusive right contemplated by the United States Constitution until the courts decide that he is not the first inventor.

Under such an arrangement, if proof of infringement carried with it as a matter of course a preliminary injunction, probably the majority of the patent lawyers would go out of business, but the best of them would continue. Probably the majority of the large corporations would be enjoined until the inventors got their rights, and probably the majority of the ablest inventors in this country would resign their present jobs and again begin to produce and patent valuable inventions.

As there are probably more infringed patents, fewer independent inventors, more successful patent lawyers, and fewer competent judges met with in connection with inventions in the electrical field than in any other field, the ELECTRICAL WORLD is an especially appropriate forum for the discussion of these questions, and it is, therefore, to be hoped that many inventors who have recently expressed their views privately will do so pub-

licly as to the difficult questions involved in a consideration of reforms in our patent system.

The practical question for American inventors is: How can the American inventors secure the support of the representative American patent lawyers in advocating patent reforms which will give to the real inventor the maximum protection at the minimum expense instead of the present system of minimum protection and maximum expense?

Bronxville, N. Y. H. Ward Leonard.

A Severe Case of Electric Shock.

To the Editors of Electrical World:

Sirs:—We recently had a very remarkable case of electric shock, which, in view of the high voltage on the line and the subsequent recovery of the patient, I believe is unique in the annals of electrical accidents and will therefore be of interest to the readers of the Electrical World.

In the lower story of our transformer house are located the 50,000-volt step-up transformers, which are star-connected with the neutral grounded, the high-tension leads passing upward through the concrete ceiling, which is the floor of the switch room above. On the occasion in question some employees were at work in the far end of the upper room, when they noticed a man, who was not an employee, standing near the oil switches. On being requested to come away from the dangerous locality he started to leave, but instead of following the safe passageway near the wall of the building, he walked between the 50,000-volt leads (coming through the floor) and the 50,000-volt series transformers to which they connected, when his head came very close to or in contact with one of the leads, receiving the Y-voltage of 30,000 between the lead and the concrete floor, which rendered him rigid; he then fell forward, striking his shoulder against the middle high-tension lead and suffered a second shock, but finally falling clear of the wires.

His head and shoulder and one heel were very severely burned, the nails in the heel of his shoe being partially fused where they were in contact with the concrete floor, and the overload circuit-breakers on the switchboard were opened by the short-circuit through his body. He was finally resuscitated after an hour's hard work and to-day, three months after the accident, is regularly at work.

Gainesville, Ga. F. P. Catchings.

DIGEST OF CURRENT ELECTRICAL LITERATURE

Generators, Motors and Transformers.

Turbo-Generators.—An account of the discussion which followed the paper of Stoney and Law, recently abstracted in the Digest. S. P. Thompson referred to the progress made in the utilization of materials in dynamo construction, taking as the basis of comparison the coefficient obtained by multiplying together the diameter and length of the armature core and dividing by the kilowatt output. For direct-current machines this coefficient was 2.4 in 1884 and has now been reduced to from 0.98 to 0.83. In the case of alternators the same coefficient has been reduced from 3 in 1889 to 0.64 at present. Most of the speakers did not like the use of smooth-core armatures and metal brushes employed by the Parsons Company and preferred slotted-core machines with carbon brushes. W. Parker said that in the design of direct-current turbo-dynamos the real difficulty is not vibration, but excessive heating, and that it has been found absolutely necessary to use carbon brushes. M. Walker thinks the cylindrical type of field magnet to be better than the salient pole type.—Lond. *Elec.*, April 10.

Lamps and Lighting.

Mechanical Equivalent of Light.—C. V. Drysdale.—A paper giving comparisons between the ideal and the actual efficiency of electric lamps. The efficiency of a lamp is the ratio of the light it gives to the power supplied. This definition suffers from the well-known imperfection due to the color of the light emitted. Strictly speaking, lights of different colors cannot be quantitatively compared. In comparing two lights of different tints, the only scientific method is to integrate the light over the different wave-lengths, comparing photometrically only the lights of the same wave-lengths, and adding up the amounts so found. This has to be done over the visible spectrum. The author isolated the latter by a prismatic contrivance which is more effective than screens. He then measured the radient energy by means of a bolometer, and the light in the various parts of the spectrum by means of a spectrum photometer. The results obtained with a standard incandescent lamp show than an ideal lamp giving white light would furnish 10 cp per watt. This would mean that all the radiant energy would appear in the form of light evenly distributed over the spectrum. For the brightest mono-chromatic light (540 $\mu\mu$) the amount so furnished would be 17 cp per watt.—*Bull. 274 of French Physical Soc.;* abstracted in Lond. *Elec. Eng'ing,* April 9.

Metallic-Filament Lamps and Central Stations.—H. W. Handcock and A. H. Dykes.—A paper read before the (Brit.) Inst. Elec. Eng. on electric supply prospects and charges as affected by metallic-filament lamps and electric heating. The authors draw attention to what would happen if high-efficiency electric lamps became universally adopted, and show that the effect would be disastrous for the energy supply authorities. They are convinced that it is essential that present systems of charging should be modified so that electric heating would be encouraged and short-hour consumers made to pay their fair share of the capital costs. The system proposed is a fixed price per kilowatt of estimated demand, determined by the capital costs of the supply system, and a low charge per kw-hour fixed by the production costs, no distinction being made between energy used for lamps and for motors, thus simplifying the wiring. A limit indicator should be fixed to indicate to the consumer by dimmed lamps when he is exceeding his rated consumption.—Lond. *Elec.*, April 10.—In the discussion which followed A. Wright deprecated such advertisements as "70 per cent discount on your bills," instead of "three times the light for the same bill." He pointed to the enormous increase in business which would accrue through cheaper light and to the necessity of reducing the cost of service connections. At present it cost nearly as much per kilowatt to connect to a house as to build a station. H. Hirst stated that new osram lamps can now be paired with old ones. He thought there was no need to resort to the panic measures suggested by the authors. B. Smith did not approve of the proposed "contract demand" system of charging. W. R. Rawlings, as an electrical contractor, objected strongly to the Wright system of charging, and favored the authors' system. F. M. Long described a system in use at Norwich in which the consumer is charged an annual sum of 12 per cent of the net assessment of his house plus 2 cents per kw-hour.—Lond. *Elec. Eng'ing,* April 16.—In a long editorial on the subject it is said that English direct-current central stations are practically all supplying energy at 200 volts and more. If 8-cp lamps are displaced in favor of metallic-filament lamps the consumption is increased, and the cost of lamps become more expensive; if 16-cp lamps are similarly displaced there is not very much difference in the consumption, assuming, of course, that a single metallic-filament lamp does not take the place of two or more carbon lamps. In general, therefore, the direct-current stations are not likely to suffer much from a reduction of load while the consumers will principally gain in light. It is different with alternating-current systems, and on account of the easy transformation of

voltage the position is more difficult from the supply point of view and better from the consumers' standpoint. It is thought to be not unlikely that an e.m.f. of, say, 50 volts may come into favor with further developments, so as to permit of greater elasticity in the lighting.—Lond. *Elec.*, April 17.

Metallic-Filament Lamps.—The free supply of low-voltage metallic-filament lamps in England has caused a rush of manufacturers to produce inexpensive fittings, so-called "series adapters," to use two or more lamps in series on circuits of 100 volts or more. Under such conditions the metallic-filament lamp does not show to best advantage in direct-current circuits. On alternating-current circuits, cheap autotransformers are being installed in large quantities. Although their magnetizing losses may be small (three or four watts), the fact that they will rarely be registered by the meter will result in a considerable loss of energy if a large number of such transformers is installed. Central stations should therefore insist upon a certain standard of efficiency in such transformers before permitting them to be connected. The influence of many small transformers on the power factor of the system, although injurious in tendency, is unlikely to become important, since the light-load current will be small in amount and mostly out of time-phase with the e.m.f. in daylight hours. Comparative tables of cost are given for the lighting of a small house with 18 lamps of which 15 are rated at 16 cp and the others at less. It is shown that the use of both metallic and carbon-filament lamps at 100 volts (both kinds mixed, with mostly metallic filament lamps), compared with the use of all carbon lamps at 200 volts, results not only in a better lighted house, but in reduction of cost by more than one-third. The initial outlay in this instance is only the cost of the transformer, and experience extending over 18 months appears to show that, given good care in handling, the useful life of the metallic-filament lamps is three to four times that of carbon lamps, thus rendering the cost of renewals practically equal in each case at present prices. —Lond. *Elec. Rev.*, April 10.

Metallic-Filament Lamp.—An illustrated description of a new metallic-filament lamp of British make, invented by F. Harrison and called the "British Metalite." The filament is an alloy of tungsten and some other metals, and consumes from 0.8 to 1.5 watts per candle, according to life and candle-power. Thus the 115-volt, 20-cp lamp runs at 0.9 watt per (Hefner) candle, and has a life of over 1000 hours. This same lamp, run on a 100-volt circuit, would, according to the pamphlet issued by the manufacturers, give 10 cp at a consumption of 1.5 watts per candle. A 34-cp, 200-volt lamp can also be obtained. The 200-volt, 34-cp lamp consists of six filaments (six loops) arranged in series. An alternative design for this lamp has nine filaments, the length of each double filament being 2 2/8 in.

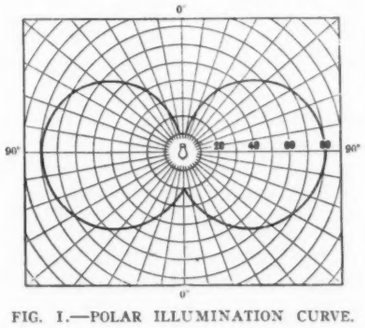


FIG. I.—POLAR ILLUMINATION CURVE.

The 100-volt lamp has four or five filaments in series. The filaments are cemented to the supporting wires at the top, and are also supported at the bottom by means of a zigzag spring. The filament itself is particularly smooth, and has the appearance of a very fine steel wire. The finest filament has a diameter of 0.0264 mm. Blackening of the globe does not take place unless the lamps are run at a consumption of 0.5 watt or less per candle, when the temperature is so high that the filament commences to volatilize and the metal condenses on the surface of the glass. On account of the symmetrical arrangement of the filaments, the horizontal distribution of light is perfectly uniform. The distribution in a vertical plane is shown in Fig. 1, which is the polar illumination curve for a lamp without any shade. For the 90-cp, 120-volt lamp the candle-power rises within the first 60 hours to 95 and then falls to 90 again after a life of 1000 hours. The amperes fall steadily from 0.9 to 0.85 and the watts per candle fall to about 0.8 after about 60 hours and rise again to slightly over one after a life of 1000 hours. The lamps are said to run better with alternating current than with direct current and better with high than with low frequency. Lamps are made for all e.m.fs. from 1.2 to 250 volts. The 250-volt lamps have candle-powers from 42.5 to 188.—Lond. *Elec. Eng'ing*, April 16.

Generation, Transmission and Distribution.

Combination of Stations in France.—G. DARY.—An illustrated article on the distribution of electrical energy on the Mediterranean Coast in France. The huge organization of the Société d'Energie Electrique du Littoral Méditerranéen is an example of the distribution of electricity over an extended area where the available waterfalls, while numerous, are extremely irregular in their individual output, and can consequently be arranged to give a regular supply of energy only by a system of general concentration. The company now actually controls a total of 56,000 hp of which 34,000 hp is obtained from waterfalls. The company controls 16 interconnected different stations. The interest in this undertaking consists mainly in the reliability of operation resulting from the combination of different hydro-electric stations. Some of them are established on streams of glacier origin, and others on rivers fed by rainfall. It is possible, therefore, by careful combinations of the different plants to eliminate the influence of periods of low water which arise at different seasons in connection with both sources of hydraulic supply. Furthermore, by having a certain number of steam-driven plants available, it is possible to reduce to a minimum any interruptions to the service which might arise from abnormal atmospheric conditions. The reliability thus obtained is comparable with that of a steam-operated plant equipped with reserve engines and generators, and the flexibility is generally much greater by reason of the considerable reserve power available.—Lond. *Elec. Rev.*, April 24.

Hydro-Electric Stations in Switzerland.—Continuation and conclusion of the long serial giving a description of the typical arrangements of hydro-electric generating stations in Switzerland. In the last two instalments the usual equipment of alternating-current stations of the line and of the substations is described.—*L'Ind. Elec.*, March 25 and April 10.

Electric Cranes.—H. H. BROUGHTON.—Continuations of his long illustrated serial. In the present instalments the author deals with collectors, switchgear and wiring. Two typical diagrams of connections are given, and from these have been deduced simple rules for determining the number of cross-wires required to supply energy to the various motors. Types of line insulators, supports and current collectors are then described, with examples covering the best practice. Installation material for revolving jib cranes is dealt with at some length, and collector rings and cable-drums of English make are described. In order to protect crane equipments against overloads and short circuits, and to facilitate testing, it is usual to provide a switchboard with a double-pole main switch and a double-pole fuse, and single-pole circuit fuses. For high-voltage and continuous-current equipments, circuit-breakers and magnetic blow-out fuses are recommended. "Association" cables, 600 megohms grade, should be used for wiring, and the insulation resistance of each motor-circuit should be observed regularly. Ground and wall connecting boxes suitable for connecting to outdoor cranes, more particularly dock cranes, are also described.—Lond. *Elec.*, April 10 and 17.

Electric Installation of Rolling Mill.—O. ALLEN.—An illustrated description of the electric installation of a rolling mill at Sandviken in Sweden. It is a three-phase plant, and in order to equalize the rapidly-varying load, use is made of a motor-

generator connected with a booster and a storage battery, the booster being excited by a special converter connected to the supply mains.—*La Lumière Elec.*, March 21.

Traction.

High-Tension Roads in Europe.—An illustrated article on the present status of high-tension direct-current and alternating-current railways in Continental Europe. Compared with the United States, in Europe the three-phase system has been a more active competitor to the direct-current and single-phase systems. Several 900 and 1000-volt direct-current lines are noted. Of three-phase railways the Valtellina road and the Simplon Tunnel are dealt with. Of single-phase railways the Valle-Maggia 5000-volt, single-phase system, equipped by the Oerlikon Company, and the generating station for the Blankenese Hamburg single-phase line are noted. The generating station contains four 1250-kw, 6300-volt, 25-cycle alternators. The transmission e.m.f. is 30,000 volts, the trolley e.m.f. 6300 volts. Sixty motor cars are used. A test line has recently been built by the Prussian State Railways at Oranienburg, the purpose being to study ballast, rail joints, ties, etc., in a shorter period than would be possible under ordinary operating conditions. It is also intended to use this section for testing motors, electric control systems, etc., as to their availability for trunk line service. The track, which is built in a forest, is circular, 1.75 km (1.08 miles) long and without grades. Cars can be operated on it at speeds up to 50 km (31 miles) an hour. Up to the present time experiments have been conducted with two 52-ton motor cars, each equipped with two Winter-Eichberg single-phase motors having an "hourly" rating of 110 hp, a "continuous" rating of 45 hp and a "maximum" rating of 125 hp. The trolley e.m.f. is 6000 volts, 25 cycles, collected through pneumatically-operated sliding bows. The trolley wire is suspended as a catenary. An unusual feature about the tests is the control of the car from a small building along the route and the automatic numbering of round trips.—*St. R'y Jour.*, May 2.

Single-Phase Road.—An illustrated description of the York and Hanover 6600-volt, 25-cycle, single-phase, high-speed railway in Pennsylvania which has a length of 18½ miles. The cars are equipped with four 75 hp Westinghouse motors connected for multiple operation with unit-switch control system. —*St. R'y Jour.*, April 25.

Switzerland.—S. Herzog.—A summary of electric railways built in Switzerland in 1907. Some notes are also given on lines projected or in course of erection.—*La Lumière Elec.*, March 28.

Installations, Systems and Appliances.

Direct-Current High-Tension Electric Supply.—An editorial of the slow progress which has been made by the direct-current, high-tension electricity supply system, called in England the "Oxford" system from its first installation at Oxford. The largest installation of this system is that in Hull, which is very satisfactory, the problems of commutation and insulation having been practically solved. With this system motor-generators are installed in substations in different parts of the supply area; these stations are unattended, being controlled entirely from the central station. As soon as the high-tension motor, to which is coupled the low-tension generator, has run up to speed, the low-tension end is automatically paralleled with the network. Even though the number of substations may considerably exceed that of an alternating-current direct-current system, yet since the substations can be controlled entirely from the generating center, the cost of attendance is reduced and the supervision of the supply is concentrated. In the same issue the detailed illustrated description of the switch gear used in the Hull station is concluded.—Lond. *Elec.*, April 10.

Charging for Electrical Energy.—T. Gruber.—The author discusses several methods of charging for electrical energy in which the number of hours for which the installed lamps, etc., are used is taken into consideration. In the oldest method the charge was based on the number of kw-hours divided by the number of kilowatts at which the installed apparatus and lamps were rated. A better system is that first introduced by Wright, in which the charge is based, not on the rating, but on the maximum load really obtained in the installation. To reduce the hardships of this system, Agthe uses maximum-demand indicators, which register only a maximum demand lasting for at least a quarter of an hour. The present author recommends the basing of the charge on what he calls the "normal" number of hours of using the lamps. From statistical data it may be shown that a certain average figure of lamp-hours consumed per year per number of lamps installed belongs to every class of offices, shops, public places, etc., which close at a certain hour. This figure will be higher for stores closing at 8 or 9 o'clock than for offices closing at 5 or 6, while the highest figure will be obtained for restaurants and amusement places kept open all night. A much higher percentage of the installed lamps are used simultaneously in commercial places than in residences. The author divides all the customers up into classes according to their occupation. In residences, statistics show that the maximum load corresponds to the simultaneous use of about 75 per cent of all the installed lamps. The size of the meter is to be chosen accordingly. But what is called the "normal" lighting load in residences starts at about 12 per cent of the rating of the lamps installed. It is recommended to register the time during which the installation is used at or above its normal load (at or about 12 per cent of the lamp ratings in the house installation). The method of charging recommended combines a fundamental fixed rate per kilowatt with a rate per kw-hour on the basis of the above considerations. The object of the method is to reduce the charge for residence lighting to a fair figure, since with the relatively long hours of normal load they represent satisfactory customers, and it is necessary to do so in order to enable electric lighting to compete with gas lighting.—*Elek. Zeit.*, March 26.

Electricity on Shipboard.—A long and fully illustrated description of the electric equipment of the steamship *Mauretania*. —Lond. *Elec. Rev.*, April 3, 10 and 17.

Wires, Wiring and Conduits.

High-Tension Insulators.—C. J. Greene.—The first part of a long article on high-tension insulators for overhead transmission lines. The author thinks that on nearly all overhead lines the size and cost of insulators have been needlessly great in consequence of a lack of exact knowledge. The author has carried out a number of tests at e.m.fs. up to 100,000 volts of three types of insulators of English make shown in Fig. 2, all of best quality vitrified porcelain, specially made for high-

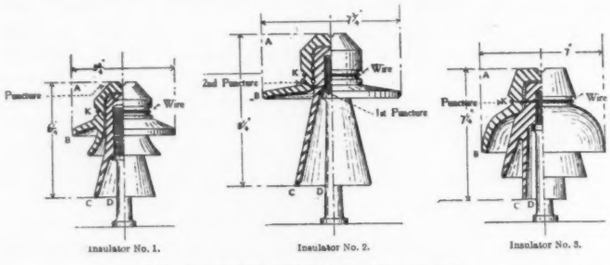


FIG. 2.—HIGH-TENSION INSULATORS.

tension lines. In every case the pin was earthed, and the pressure was applied to a soft copper binding wire bound round the side groove of the insulator. The end of the wire, after being fastened to the insulator, was carried vertically upward so as not to reduce the arcing distance to the pin. The arcing distance during the test was, therefore, in every case *K B C D* for the dry insulators. The over-all diameter varied between 5¾ in. and 7¾ in. and the over-all height between 6 1/5 and 8 1/5. These insulators were tested dry and wet, and in general it seems that the average puncturing e.m.f. of the porcelain tested is approximately 100,000 volts per inch. Some special observations made during the tests are interesting. When an insulator of type No. 2 was wet all over with clean, fresh water and a rising pressure was applied, the first spark jumped across at 45,000 volts and an arc almost established

itself, but the heat thus generated caused the insulator to dry and the arcing ceased. The pressure was then gradually increased, and with each slight increment of pressure, an arc attempted to establish itself, but was extinguished by the further drying of the insulator. At about 90,000 volts, when the insulator was probably quite dry, a permanent arc was coated with a mixture of coal dust and water. The process of the insulator drying and cleaning itself is interesting, but it is probable that it takes place with sufficient rapidity to be of service only at high voltages. An insulator does not by any means necessarily puncture in its thinnest place nor does its puncture necessarily form the shortest path of breakdown between line and pin. The insulator punctures at some point of local weakness which the electric pressure finds. It is probably quite a mistake to make any single part of an insulator with a thickness greater than 1 in. Masses of porcelain vitrified under great heat suffer from the same toughness as large masses of iron which cool unequally. By unequal cooling local internal stresses are set up which later result in a breakdown.—Lond. *Elec. Rev.*, April 24.

Electrophysics and Magnetism.

Electric Discharges Through Gases.—J. J. THOMSON.—An account of his fifth Royal Inst. lecture on electric discharges through gases. The speaker summed up the relations between sparking distances, gas pressure and potential. According to the law of F. Paschen the potential difference required to spark through a gas depends merely on the quantity of gas through which the spark has to pass. If the electrodes are formed by the fixed base and the movable piston of a cylinder, then the product of gas pressure and spark length will be a constant, provided there be no leakage of gas. For the same quantity of gas twice the volume (and therefore twice the spark length) will give half the gas pressure, and the sparks would pass at the same potential difference. This law of Paschen fails, however, when applied to very small gaps of wave-length dimensions. The nature of the gas does not matter for very small gaps, but the nature of the electrodes does. The force required to strike a very short spark is very much greater than that for ordinary spark lengths. It is about 1,000,000 volts per centimeter and about the same order as that required to send a spark through a solid or liquid dielectric such as glass or petroleum. The speaker suggested that in this case the spark is no longer carried by the ions produced by collisions with the molecules. It may be carried by the electrons dragged out of the electrode by the intense electric field.—Lond. *Elec.*, April 10.

Electronic Theory.—T. A. SCHOTT.—A highly theoretical paper on the frequencies of the free vibrations of quasi-permanent systems of electrons and on the explanation of spectrum lines. It is shown that no system which includes electric charges in orbital motion can be absolutely permanent, for orbital motions always imply a radiation of energy. A degree of permanence sufficient to allow of the production of fine spectrum lines can be expected only from systems built up of coaxial circular rings of equi-distant electrons.—*Phil. Mag.*, April.

Units, Measurements and Instruments.

Water Rheostat.—An account of the discussion which followed a paper recently abstracted in the Digest on artificial loads for testing generators. O. T. Davis said that as a general rule the circulating water discharge from a surface condensing plant is suitable for use as an artificial load. For a permanent resistor, he is in favor of a brick-built, cement-lined tank. For a low-voltage resistor, the plates (which may be of ½-in. sheet iron for lightness) should be fixed in frames, and the load controlled by raising or dropping the whole frame into the water. This arrangement reduces the necessary size of the containing tank. It is good practice to have a light fuse in series with each individual positive plate, and the plates may be grouped, the groups being controlled by switches. The load may then be prepared by lowering the resistor frame into the water, switching on a certain number of groups of plates and finally securing fine adjustment of resistance by further raising or lowering, or preferably by manipulating a weir on the outlet. Using water with a resistance temperature curve given in Fig. 3, the writer has found the following to be convenient distances from positive to negative plates: 100 volts, 2 in.; 200 to 300 volts, 3 in.; 400 to 600 volts, 5 in.; 1000 volts, 7 in. Iron-wire resistors are best arranged in a box, and should be well swept with water. If run at a density of about 10,000 amp per square inch their life is fairly long. R. K. Keer gave

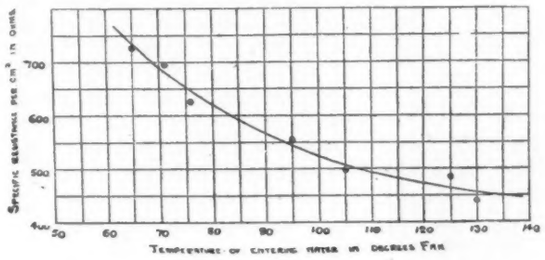


FIG. 3.—RESISTANCE TEMPERATURE CURVE.

details of a liquid resistor in use in an electrical laboratory in Manchester. The electrolyte used is a 2 per cent solution of aluminum sulphate, the electrodes being lead plates. This arrangement is very clean, as there is practically no sediment or fumes formed.—Lond. *Elec. Rev.*, April 3.

Flaming Arc Lamps.

BY A. S. PEARL.

Among the more prominent recent developments in electric illumination is the so-called flaming arc lamps, as it is in this type of lamp that the highest efficiencies in electrical illumination have been secured. The fundamental basis of this improved efficiency is that the electrodes have been impregnated with a combination of metallic salts, such as compounds of calcium, barium, strontium, etc., this change first being brought to notice by European engineers.

The principal phenomenon exhibited in the arc produced with metallized carbon electrodes is the increase in the length of the arc. For equal voltage, the length of the arc which then becomes a "flaming arc" is approximately five times as great as the arc between the usual type of solid carbon electrodes. Then again the aspect of the arc becomes quite abnormal, as there is no longer a great and brilliant crater in the positive electrode; in other words, it is no longer the incandescence of the carbon which supplies the chief source of light, but the arc or flame itself becomes luminous.

In the pure carbon arc, the largest percentage of light comes from the incandescent carbon points, while in the arc produced with impregnated carbon electrodes, the arc as well as the electrode points becomes luminous and the carbon being impregnated with metallic salts produces "a metallized carbon arc."

Various designs of lamps have been made to use such impregnated carbon electrodes. In the earlier lamps of Bremer, electrodes were operated in a vertical position similar to those in the pure carbon arc. The vertical axis arrangement of the electrodes did not prove entirely satisfactory when carbon electrodes mixed with mineral substances were used, owing to the production of slag, which, when melted, fell upon the lower electrode, thus preventing the free passage of the current and causing the arc to become very unstable.

To overcome this difficulty, it was necessary to design a new type of lamp which instead of employing electrodes placed in a vertical position and in alignment, are arranged so that they converge with their free ends downward, which has proved much more satisfactory owing to the fact that the slag drops away from the electrodes.

Ordinarily when the electrodes are thus arranged the arc would form above the points, but by locating an electromagnet above the arc, the latter is projected by the repelling influence

of the magnetism which maintains the arc between the points

This lamp was shown at the Paris Exposition in 1900, creating much favorable comment. Many different lamps have since been placed on the market to use impregnated carbon electrodes.

On account of the large volume of light given off by these lamps, they have been conspicuous during the past few years as an advertising feature, being used extensively for lighting fronts of stores, theaters, large signs and amusement parks.

The flaming arc lamps thus far used have produced a golden-yellow or vivid-white light, according to the composition employed in the electrodes. The composition giving the golden-yellow light are the most efficient and effective, as the color is hardly distinguishable from the color of the light from oil and candle flames and incandescent electric lamps. This color has particular points of advantage for exterior illumination, as it is least absorbed by smoke and fog.

FLAMING ARC LAMP.

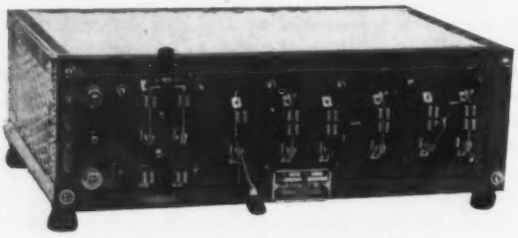
The flaming arc is therefore well adapted for lighting foundries, iron mills, railway stations, railway yards or other large enclosures where smoke abounds, or for lighting large enclosures such as machine shops where it is necessary to hang the lamps a considerable distance from the floor in order to clear traveling cranes and moving machinery.

Heretofore, most flaming arc lamps used in this country have been imported. These lamps were usually more or less complicated, but owing to the increased demand for flaming arc lamps, it has been found desirable to develop more simply constructed lamps which would more nearly meet the conditions in this country. Such lamps are being marketed by the Central Electric Company, Chicago, Ill. The accompanying illustration shows a G. I. lamp which represents the very latest development in American flame arc lamps.

The chief points of the lamp are as follows: These lamps are manufactured for both alternating and direct current and as they are usually operated in series on standard lighting circuits, the well-known differential winding is used. They have a clutch device, feeding both electrodes by a single clutch, making them of very simple and reliable construction. Clock mechanism and chains have been eliminated, and they are designed to use standard makes of flame lamp electrodes. All insulation is of non-inflammable material. Every part is accessible when the shell is lowered into trimming position.

Load-Rheostat for Two Voltages.

The accompanying illustration shows a meter testing load-rheostat for use at either 110 or 220 volts. The rheostat is provided with a double-throw switch which when in one position allows 5-amp steps from 0.5 to 23.5 amp to be obtained when the e.m.f. is 110 volts; when the switch is in the other position 0.5 amp steps from 0.5 to 11.5 amp may be obtained when the supply e.m.f. is 220 volts.



LOAD RHEOSTAT FOR TWO VOLTAGES.

The rheostat is designed to replace lamp-bank for non-inductive resistance load. The elements are built up of enameled resistor units. There are several switches in parallel, each switch controlling its respective resistor. Each switch is marked with the approximate number of amperes that will exist in the resistor when it is closed.

The complete rheostat weighs only 14 lb. It has been placed upon the market by the Ward Leonard Electric Company, Bronxville, N. Y.

Hillside Works of the Wagner Electric Manufacturing Company.

The Wagner Electric Manufacturing Company, of St. Louis, Mo., has recently built a new plant at Hillside Station, about 800 ft. west of the city limits. The site comprises about 15 acres and is admirably located as regards light and air and has excellent shipping facilities. The layout of the buildings is such as to give opportunity for expansion and also to reduce to a minimum the cost of manufacture. The materials are received at the north end of the plant and are stored in the rough stores building. All castings from the foundry will either be stored in this building or will pass through it en route to the workshops. The individual factory buildings are located at right angles to the rough stores building, the material being placed in the stores building at such a place as will insure its being loaded directly onto trucks running into the individual factory buildings. The latter have been laid out as units in themselves, no partially completed product being transferred from one building to another for completion.

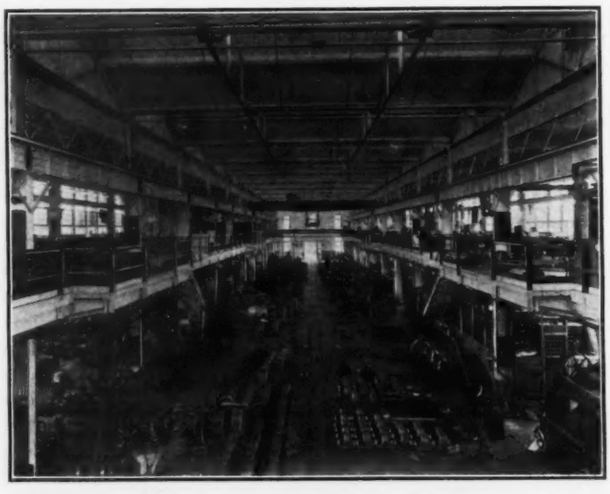


FIG. 1.—MAIN MACHINE SHOP.

All the buildings are served with traveling cranes operated with Wagner three-phase motors and are also fitted with hand cranes and air hoists to further the expeditious handling of material and finished product. A feature of the layout is the system of subways which connects the various buildings and departments. The subways run through the buildings and are served by elevators located at various points throughout the plant. The material is dropped from the factory floor to the subway, there transferred to the necessary department, and raised by an elevator to the particular spot where it is wanted. This prevents trucking through the aisles and keeps the latter practically free from accumulations of material.

The plant comprises a transformer building, a punch shop, main machine shop, service building, administration building, power house, water tank and reservoir, and is connected with the main line of the Wabash Railroad by a spur track. The buildings are excellently designed as regards light and ventilation and are fitted with all modern conveniences, such as metal lockers, lunch rooms, etc. The main machine shop is shown in

Fig. 1. This building is 100 ft. wide by 312 ft. long and has galleries on either side. The building has a saw-tooth roof, the vertical panels facing north. A 10-ton crane, operated by three-phase motors, runs the length of the building, and the shop is equipped with the most up-to-date machinery known to the trade.

A corner of the transformer shop is shown in Fig. 2. The

FIG. 2.—TRANSFORMER SHOP, SHOWING OVERHEAD GALLERY CONSTRUCTION.

heavy and large transformers are built on the floor of this building, while the coil winding and insulation processes are conducted in the gallery. A loading platform is provided, as shown, so that the overhead crane may serve the gallery. The double-track subway has turntables serving the elevators, and frequent switching points are provided so that trucks may be sent from one track to the other as occasion demands. The subways also carry the various power and lighting feeders together with the refrigerator and water supply.

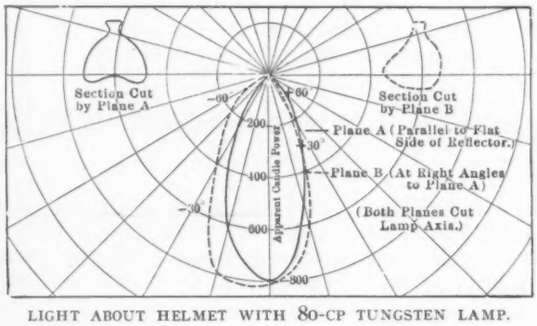
The power house contains a 250-kw, three-phase, 440-volt, 60-cycle alternator direct-connected to a tandem compound en-

FIG. 3.—SECOND FLOOR OF PUNCH SHOP.

gine; a 100-kw, 133-cycle, 110-volt, single-phase alternator for testing purposes and a 50-kw, 500-volt, direct-current generator also for testing purposes. The output is controlled by Wagner switchboard indicating instruments and measured by Sangamo watt-hour meters. The boiler plant comprises two Heine boilers fitted with American chain-grate stokers driven by Wagner single-phase motors.

Helmet Reflector with Tungsten Lamps.

The accompanying curves show the light distribution in two planes about a Helmet reflector equipped with a tungsten lamp giving 80 mean horizontal candle-power. This Helmet reflector has already been illustrated in these columns, and is made by the National X-Ray Reflector Company, 245 East Jackson

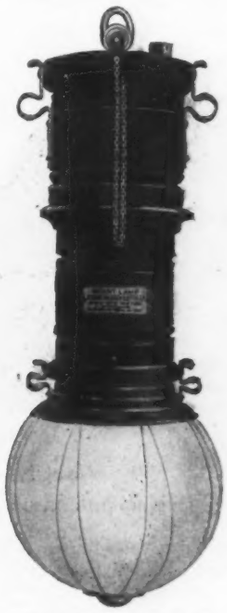


LIGHT ABOUT HELMET WITH 80-CP TUNGSTEN LAMP.

Boulevard, Chicago. It is especially designed for the lighting of high, shallow show-windows, and for this reason is made a large size, 12 in. diameter by 11½ in. high, in order to reflect as large a percentage of the light as possible down where it is needed in the show window. The concentration obtained is something remarkable, reaching over 800 cp in the direction of the bottom of the window, and being in excess of 600 cp over an angle of over 35 deg. The reflector is intended to be used so that the plane *B* indicated on the photometric curve is at right-angles to the window pane, while the plane *A* is parallel with the pane.

Flaming-Arc Lamp.

The Grant flaming-arc lamp, manufactured by the German-American Electric Company, New York, recently placed on the market, is extremely simple in construction. It possesses no clockwork, gears, clutches, shunt-coils, resistors or dash pots,



FLAMING ARC LAMP.

the electrodes being fed forward by gravity alone. The solenoid is provided with a floating plunger so adjusted that when the lamp operates under the proper voltage, it will separate the electrodes to a given distance, and use the amount of current for which they are designed. On account of this arrangement, no extra resistor is needed and no resistance heat loss takes place, and the lamp is highly efficient. Variations in the line

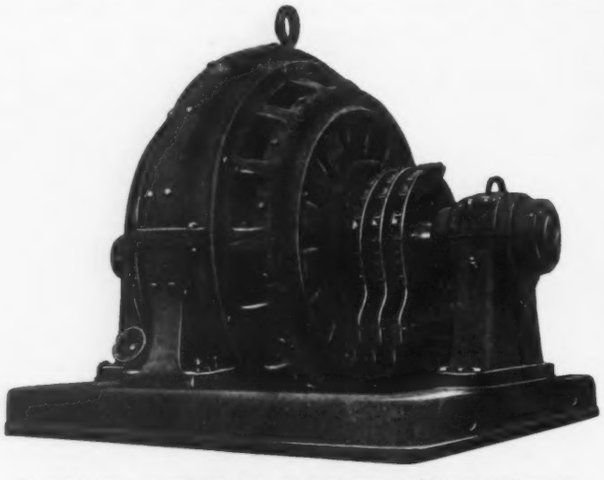
voltage which occur from time to time cause the solenoid to attract the plunger more or less strongly and thereby hold the arc length at the proper value.

The feed mechanism of the lamp is controlled by a lateral support, so arranged that as the electrodes are consumed underneath the support, the negative electrode deteriorates sufficiently to allow the electrodes to move forward properly. The frame of the lamp consists of top and bottom pieces held by four substantial rods and one additional rod in the middle to guide the electrode holder properly. The lamp is only 26 in. in height and uses 24-in. electrodes; it weighs 20 lb.

Rotary Converter with Synchronous Voltage Regulator.

The voltage delivered at the commutator of a rotary converter usually bears a fixed ratio to that at the collector rings. In lighting and industrial work it is essential that the potential on the direct-current feeders be maintained constant without regard to the variations in the supply voltage, and several methods have been devised for regulating the potential. Rotary converters are often provided with a series winding, and, when accompanied by a suitable reactance on the alternating-current side, this arrangement has been the only one for maintaining the voltage which did not entail considerable auxiliary wiring. Potential and induction regulators are used in many installations. Although these devices can be fitted up to control the voltage automatically, they not only occupy considerable space, but at the same time add a large amount to the auxiliary wiring required.

The rotary converter with synchronous voltage regulator illustrated herewith is designed to supply, in one compact, simple and efficient machine, an entirely self-contained piece of apparatus which will accomplish all that has heretofore been done by the use of the potential or induction regulator. These machines can be designed for either automatic or non-automatic control of the voltage at the commutator. Several of these converters are now being used by the New York Edison Company, where it is stated that they have proved very successful. In designing these machines it was necessary to proportion



ALTERNATING CURRENT SIDE OF SIX-PHASE ROTARY CONVERTER.

them so that they could be installed in existing substations in the same space that had been occupied by rotary converters of an earlier design.

The machine illustrated herewith is of 1000-kw nominal rating and is designed to deliver direct current at from 225 to 300 volts when receiving alternating current at 166 volts, six-phase, 25 cycles. These machines have 16 poles and, therefore, operate at 187.5 r.p.m.

The rotary converter with synchronous regulator consists of a rotary converter of ordinary construction combined with a small alternating-current generator, the field and poles of the latter being supported by a bracket from the frame of the converter-field structure. The alternating-current regulating armature is carried on the same shaft with and between the armature of the rotary converter and the slip rings and, therefore, requires no separate collector or brushholder mechanism. The field coils are supplied with current from the substation busbars. The commutator voltage can be either raised or lowered by altering or reversing the field excitation of the alternating-current generator portion of the machine in a manner similar to that adopted in controlling the voltage of an alternator. The sole difference lies in the fact that the synchronous regulator is designed so that the normal commutator voltage is delivered with normal voltage on the alternating-current side with zero excitation of the regulator field. The commutator voltage is increased or decreased by altering the strength or the polarity of the regulator-field exciting current.

The advantage of this method of controlling the commutator voltage lies in the wide range of accurate control which can be secured without affecting the power factor of the circuit and the compactness of the arrangement.

The rotary converter with synchronous voltage regulation has been placed on the market by the Westinghouse Electric & Manufacturing Company. It is claimed that the new arrangement makes the rotary converter, within limits, as flexible and as easily controlled as a motor-generator set, retaining at the same time all of the advantages of the rotary converter.

Vertical Shaft and Back-Geared Motors.

Fig. 1 illustrates a new direct-current, Roth vertical-shaft motor for use with centrifugal pumps, the pumps being placed at water level. This motor can be furnished either with or without the tripod base, as shown. Some pump manufacturers prefer to make their own motor bases and brackets, in which

FIGS. 1 AND 2.—VERTICAL SHAFT AND BACK-GEARED MOTORS.

case the tripod base is left off and a finished surface is left on the bearing bracket to which it is easy to make connection with any style of bracket base. Fig. 2 shows one of the new direct-current back-geared motors of the same manufacture, and from the view the heavy proportions can be understood. These machines are substantially made, and run very quietly. Both these motors have been recently brought out by Roth Brothers & Company, 29 South Clinton Street, Chicago, which concern reports operating its works practically with full force, and even running overtime during the recent financial flurry. The company now has a New York office at 136 Liberty Street.

Electric Irons for Tailors.

To meet the demand upon the part of manufacturing and custom tailors for an iron embodying the same principles as the Westinghouse electrically heated sad iron, the Westinghouse Electric & Manufacturing Company has developed the goose shown in the illustration. This goose is designed to endure the same rough usage as the plain cast-iron goose and to fulfil all the requirements of the tailor with the elimination of the heat, dirt and inconvenience incident to other methods. It is made in two shapes—wide and narrow. The wide goose is 5½ in. by 8½ in., and comes in four different weights—12, 15, 18 and 22 lb. The narrow goose is 3 in. by 10 in. and is furnished in three different weights—12, 15 and 18 lb. Both types are made for three different voltage ranges—100-107, 108-115 and 116-125.

In order to avoid complication, a single heating element is provided which is sufficient to bring the iron to a working temperature and to maintain it uniformly during the heaviest service. On intermittent or light work the circuit can be turned off a considerable portion of the time, and the irons are constructed so that their working surface will remain hot a long time after the iron has been thoroughly heated.

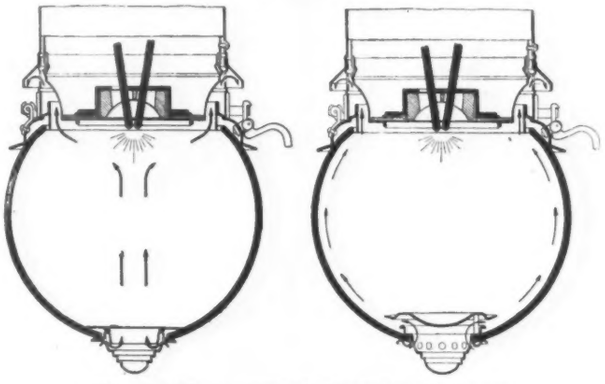
The heating element is a thin steel grid, arranged to distribute the heat evenly over the entire working surface of the iron. This grid is hermetically sealed within a fireproof dielectric of good thermal conductivity, and is held between two solid iron blocks, one of which forms the working surface of the

TAILOR'S ELECTRIC IRON.

iron, the other, immediately above it, serving as a heat reservoir or thermal equalizer by which the constant input of heat from the heating element is stored up and given out to suit the irregular demands of the work. These two portions of the iron are secured together and in effect form a solid mass which is separated from the top of the iron by means of an air space which forms an effective heat insulator.

Improvements in Flaming Arc Lamps.

Every flaming arc lamp when in operation gives off fumes and other products of combustion. The gases usually escape, but the ashes form an incrustation on the globe and absorb a great deal of the light. For this reason the globes must be regularly cleaned at short intervals and this adds to the maintenance cost of the lamp. In properly constructed lamps, a strong current of air enters through holes in the ash tray and drives before it the gases formed by the combustion of the carbons. Fig. 1 shows the usual scheme of ventilation, from which it is evident that the incoming current of air passing directly from the bottom to the top of the lamp, as indicated by the arrows, does not force out the gases next the globe and the ash contained in them. In order that the air shall be constrained to pass along the inside of the globe and thus sweep its surface, the Allgemeine Elektricitäts Gesellschaft, of Berlin, Germany, has devised the ash plate shown in Fig. 2. The air enters the holes as indicated and passes around the inside of the globe, escaping finally at the top. To show the



FIGS. 1 AND 2.—GERMAN FLAMING ARC LAMP.

efficacy of the device, tests were made on lamps with the old form of ash plate and with the newer form. At starting, the light in both cases was 3450 hefner candles in the lower hemisphere. After burning for 16 hours and 20 minutes, the intensity of light in the lower hemisphere was respectively 2240 hefner candles and 3390 hefner candles. The amount of light absorbed by the incrustation on the globe in the first case was 35 per cent and in the latter case 1.75 per cent at the end of the burning period.

Tungsten Diffusing Cluster.

To fill the demand for a large lighting unit of approximately the same power as the enclosed arc lamp, the General Electric Company has perfected the tungsten economy diffusing cluster. This unit provides, in addition, a light of variable intensity with a wide range of wattage adjustment without mechanical change.

The diffuser is designed primarily to carry six tungsten lamps suspended in a vertical position. Very good results, however, can be obtained by the use of either tantalum or carbon filament lamps. When the latter are used the platform carrying the lamps can be readily lowered without taking the fixture apart. This adjustable feature makes the fixture universal for all types of incandescent lamps.

The illustration shows the standard 26-in. cluster. The diffuser is made of steel, coated with white porcelain enamel on the under side and black on the top. The supporting reflector is made of brass with a nickel finish and carries springs to compensate for expansion or variation in the size of the globes. The casing is finished in streaked oxidized copper.

The 39-in. or mill type diffuser is identically the same as the 26-in., except that the diffuser is larger, and instead of being finished in porcelain enamel is coated with white zinc enamel. For store lighting, the 26-in. diffuser is recommended, and for mill and factory work the 39-in. gives more satisfactory results as regards distribution and diffusion.

It has been found from experience that the 39-in. tungsten economy diffusing cluster gives excellent results for mill lighting when equipped with three 100-watt tungsten lamps. This permits, for the same energy, somewhat closer spacing than arc lamps.

The shade is made of clear glass frosted on the inside, and as may be seen from the illustration, is curved to take the same general shape of the lamps. Placing the frosting on the inside of the shade gives a lower intrinsic brilliancy than is obtained by the same grade of frosting placed on the lamps, and does not reduce the life of the lamps. The six-lobe shade is standard for all lamp combinations, and the curvature of the shade

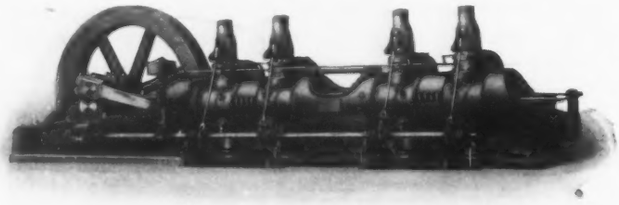
minimizes the spotted effect so apparent when part of the lamps are extinguished in a fixture having a spherical globe. By

TUNGSTEN DIFFUSING CLUSTER.

using various combinations of 40, 60 and 100 watt lamps, the cluster can be made to operate at 120, 180, 240, 300, 360 and 420 and 480 watts.

Mesta Gas Engine.

The important position in the power field now occupied by the modern heavy duty gas engine has received careful consideration by the Mesta Machine Company, and after several years of close observation of the various types developed, both here and abroad, this company has actively taken up gas engine design and construction along with its regular established heavy duty Corliss and piston valve reversing steam engines.



HORIZONTAL GAS ENGINE.

The accompanying illustration shows the general arrangement of the 600-hp, 400-kw, direct-connected unit now in process of construction in the works at West Homestead, and typifies the series of sizes called for in the designs as at present laid down.

The engines, which are designed for operation on the four-cycle principle, are built either tandem or twin tandem. This method of placing the two double-acting cylinders in tandem results in two power strokes per revolution, giving very close regulation and making it feasible to operate 60-cycle generators in parallel without the use of any form of flexible coupling. Where the twin tandem type is employed, the power strokes are doubled, and result in the same effective torque as in a cross-compound steam engine.

The design throughout is characterized by massive construction, well suited to the demands of the most severe operating conditions; but in obtaining this necessary strength, the matter of accessibility and simplicity has not been lost sight of.

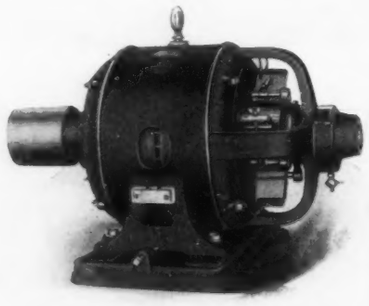
Following the American custom, the overhung crank construction is used, and owing to the tandem arrangement, attention has been given to longitudinal expansion, the cylinders being permitted to expand or contract with the varying temperature, while in no way affecting the engine alignment.

Simplicity and reliability are attained in the valve gear by first doing away with the spiral gear drive for the lay shaft, and secondly, by operating both inlet and exhaust valves from a single eccentric. All parts subject to wear are fitted with adjustable devices, the aim being to produce an engine well suited to the demands of 24-hour service.

For the development of this line of engines, ranging in capacity from 500 brake-hp to 4000 brake-hp, the Mesta Machine Company has secured the services of Mr. Frederick Ottesen, who has had wide European and American experience in gas engine design, and has spent over a year in the development of the design illustrated, which is particularly adapted to the American requirements.

Single-Phase Commutator Motor.

The motor illustrated herewith has been developed along the lines of single-phase railway motors, with the addition of some extra windings which prevent the speed from becoming excessive when the load is suddenly withdrawn. It is stated that the motor is very satisfactory for ordinary belt drive, but is particularly applicable where variable speed is required; by the use of either an auto-transformer or an ordinary resistor inserted



SINGLE-PHASE COMMUTATOR MOTOR.

in the secondary circuit excellent speed control can be obtained. It is claimed that there is absolutely no sparking at the brushes.

This motor has been placed on the market by the Ideal Electric & Manufacturing Company, Mansfield, Ohio. It is built in ratings varying from 0.25 hp to 10 hp, and for 25, 30, 40 or 60 cycles.

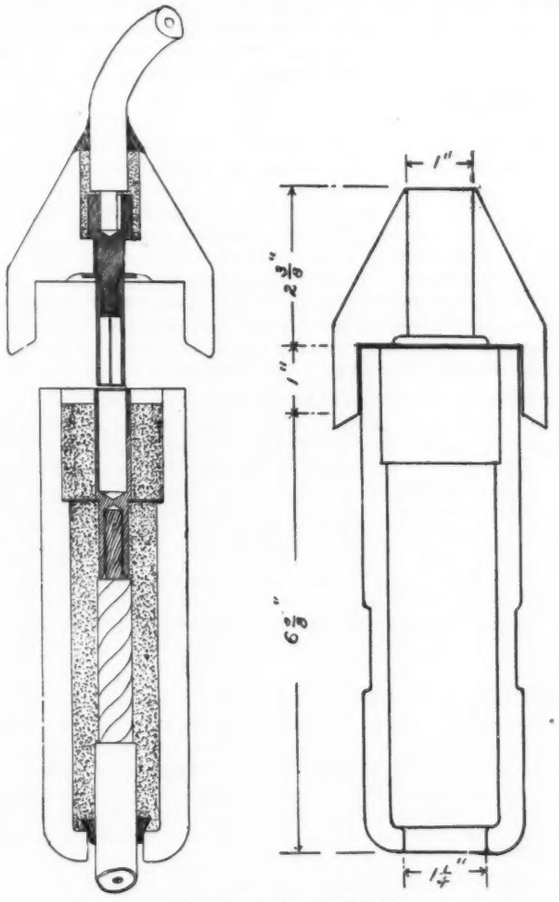
Turn-Down Incandescent Lamp.

The accompanying illustration shows a turn-down lamp made by the Economical Electric Lamp Company, of New York City. The lamp is provided with the regular 16-cp filament and with a 1-cp filament, with connectors in the base such that by simply pulling a string the lamp may be caused to give a bright or dim light, or may be switched out of circuit altogether. Lamps of this type have found a very wide use, especially in residences where frequently a dim light is required during the night. The company manufactures turn-down lamps in three styles—pull string, turn bulb and long cord. The latter type is fitted with a triple-strand lamp cord, at the end of which is a pull-chain switch to control the lamp.

TURN-DOWN LAMP.

Recent Types of Porcelain Potheads.

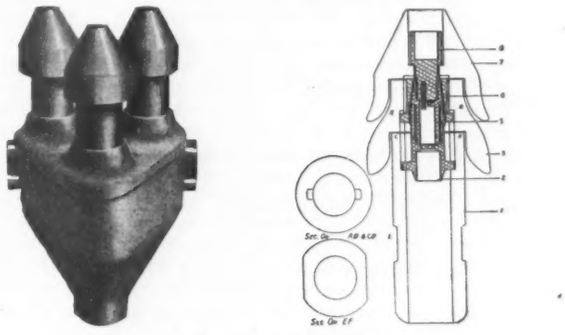
Some time ago there was illustrated in these columns a new combined porcelain pothead and disconnector for use outdoors in connecting overhead and underground lines, which was put on the market by the G. & W. Electric Specialty Company, 128 West Jackson Boulevard, Chicago. Since that time a number of additional types have been perfected. There are now three distinct types, each type being manufactured in several forms for single and multiple conductor cables. The type shown in cross-section in Fig. 1 was the first type developed, and was intended for terminating cables up to No. 0 size on voltages from 2000 to 20,000. For voltages above 6600 volts exposed to the weather, a larger petticoat than shown in Fig. 1 is used. In Fig. 1 the cable conductor terminates in a thimble, which is held in a central position in a porcelain sleeve. The porcelain sleeve extends down well over the lead covering of the cable, the space between the cable and the porcelain sleeve being filled with compound. The overhead line terminates in a split plug which is held in a central position in a porcelain cap. When the porcelain cap is slipped over the porcelain sleeve on the cable, the split plug enters the thimble or receptacle on the end of the cable conductor and forms an electrical connection. The porcelain cap protects the top of the sleeve from the weather.



FIGS. 1 AND 2.—POTHEADS.

It has been found in actual work that this type of pothead can be submerged in water, although, of course, its operation under water is not to be recommended as a regular thing. In manholes in Chicago, which have been accidentally flooded, these potheads have come through without accident, although completely submerged. Water is prevented from getting into the plug and receptacle by the air which is imprisoned under the cap.

Another form of pothead is shown in Fig. 4. This is intended for heavy conductors up to 500,000 cir. mil where heavier contact is needed than in the type illustrated in Fig. 1. The lead-covered cable terminates in part *2* and the overhead line in part *8*. The porcelain petticoat *3* turns the brass connector *6* so that screwing down on this petticoat draws the parts *5* and *2* together to make a strong electrical connection of large contact area. Fig. 3 shows how three cable conductors can be terminated in potheads of the general type shown in Fig. 1 and all three placed in an iron pot covered with a cast-iron lid, thus forming a multiple conductor detachable pothead. For some cases, around power plants and substations, where is it desired to get the advantages of the porcelain pothead feature



FIGS. 3 AND 4.—POTHEADS.

without utilizing the disconnecting feature for the purpose, the type of pothead shown in Fig. 2 was devised. This is a porcelain pothead with an ordinary soldered joint inside. The advantages of utilizing such a good insulating material as porcelain for surrounding such usually weak places in the line as potheads will be readily appreciated by all handling high-tension currents. The disconnecting feature is another strong point of these potheads; in fact, some of them are installed on branch overhead lines in Chicago purely for disconnecting purposes.

Electrically Operated Wall Plaster Plant at Syracuse, N. Y.

The Syracuse Wall Plaster Company, Syracuse, N. Y., has recently erected a two-story plant equipped with motor-driven machinery for the mixing and preparation of wall plaster, a product which up to the present time has been the result of each individual plasterer's formula or experience and dependent upon his judgment to obtain the right mixtures. The hydrating machinery, comprising a three-screw motor-driven conveyor, 16 in. in diameter, with a total length of approximately 72 ft., is installed in the basement of the plant. This conveyor operates at about one revolution per minute, making the time required for passage of the lime through its entire length one hour. Upon entering the conveyor, the lime is thoroughly mixed with water and comes out in a dried condition, after which it is pulverized.

The main floor is occupied by the mixing machinery, back of which is the dryer, conveying and lifting mechanism. A No. 2 Broughton mixer is used to receive a charge of 1350 lb. and requires eight minutes for mixing. This machine is operated by a 10-hp standard Allis-Chalmers induction motor, 1130 r.p.m., belted from a countershaft. A 7½-hp motor of the same make is used to drive an elevator of 3600 lb. capacity at a speed of 45 ft. per minute. Three sand elevators, a screen, 20-ft. screw conveyor and the knockers on the dryer are all operated from another 7½-hp Allis-Chalmers motor. These elevators are equipped with 7-in. x 4½-in. buckets spaced a foot apart and having an average lift of approximately 30 ft.

The hydrating machinery in the basement, a revolving screen on the top floor, a spindle grinder for grinding clay, and three elevators are operated from a third Allis-Chalmers 7½-hp motor. After the lime has been hydrated in the basement it is lifted to the top floor where it is mixed with sand, hair and the other ingredients used to make up the mixer charge. The average capacity of the plant for 10 hours is 710 bags of plaster each weighing 125 lb.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—Owing to excessive rain slightly less favorable crop reports were received for the last week, but indications point that crops will be much better than last year. Distributive trade remained little changed from the preceding week, quietness prevailing in practically all markets. The metal trades are still far behind and pig iron is weaker. The output in April was 6 per cent under the output for March and 49 per cent under the output for April, 1907. Collections remain backward with extensions prevalent, but money is easy, the supply far exceeding the demand, and a large amount being invested in bond issues. There was an increase in orders for structural material and two leading railroads have placed orders for nearly 100 locomotives. Failures for the week ending May 7, according to *Bradstreet's*, were 288 against 282 in the preceding week, 154 in the coresponding week in 1907. Commercial failures for April numbered 1309 and totaled, in defaulted liabilities, $20,316,408. This is the best monthly statement since last November and is still more favorable if the brokerage and other more or less speculative concerns are omitted. Compared with April a year ago there was an increase of more than $9,000,000 in defaulted liabilities, but as compared with March this year there was a decrease of $7,000,000. For the month as a whole it cannot be said that there was any appreciable improvement in the electrical trades over the preceding month, except in inquiry and sentiment. Export trade, which on an average, since the beginning of 1908, has been but about 10 or 15 per cent below last year, is commencing to show signs of a revival from the dulness which has characterized that branch during the last few weeks. The electrical department of the Allis-Chalmers Company is operating at more than 65 per cent of its capacity, turning out a great deal of small equipment and filling old orders and is employing about 7000 men of its normal number of 12,000. This condition of affairs is representative of the larger electric companies. An improved sentiment is about all that can be said for the first week in May in reference to the electrical business.

BRISTOL COMPANY MERGER.—Final details of the consolidation of the William H. Bristol Company and The Bristol Company have been carried out, and the new firm, bearing the name of The Bristol Company, is now, it is said, the manufacturer of the most complete line of recording instruments for pressure, temperature and electricity in the world. In 1889, when Prof. William H. Bristol was an instructor in the Massachusetts Institute of Technology, he started the Bristol Company for the manufacture of two patented inventions. These met with such success that other recording instruments for temperature and electrical measurements were soon after designed and adapted to a large number of different ranges and applications. In the course of the last two years the William H. Bristol electric pyrometers and smoked-chart recorders have been brought out by Prof. Bristol, and have come into wide use. Among other patents on new instruments which have been taken out is one on an electric thermometer, which has been designed for the measurement of atmospheric and refrigerating temperatures. This thermometer can be used to measure the temperature at several different points, a single instrument being arranged with switches to provide for this. An officer of the company said: "The new plans are working out very nicely and the consolidation is being brought about harmoniously, without interrupting the activities of either business. We have some splendid new lines ready to bring out, and though we feel already safe in saying that we have the most complete line of recording instruments in the world, we are going to add lines which have already in preliminary experiments proved their efficacy in actual service."

QUICK WORK ON A BIG WIRE ORDER.—A large contract was recently placed by the Indian Government with Mr. Walter G. Clark, of 135 Broadway, New York, for cables and wire for electric transmission lines in India. The placing of the contract had been withheld for a considerable period awaiting a decline in the price of copper, so that when the order was finally given it was necessary that the cable and wire should be shipped with the least possible delay. The contract was closed by telegraph, and although the wire and cable ordered was all special and required special dies, it was being turned out within 12 hours from the time the contract was closed. Moreover, on account of the distance that the material had to be transported, and the rough country, it was necessary to develop special reels and containers for shipping it, all of which had to be done after the order had been received. All this was accomplished, and Mr. Clark got out a first shipment of 300,000 lb. in time to be sent forward by the next steamer, which sailed only 10 days after the work was started. In order to be sure that all material going forward should be of the best possible grade, the entire amount of wire and cable, aggregating considerably over a million pounds, was given continuous tests for tensile strength and conductivity and each length of wire and cable shipped was drawn in a continuous length from one bar, so that the entire shipment did not contain a splice or joint of any kind. Mr. Clark is giving special attention to high tensile strength copper conductors, and a number of the most important transmission systems are being operated over cables manufactured from his design and under his supervision.

THE STANDARD VITRIFIED CONDUIT COMPANY is running its factories to the fullest capacity, turning out over 1,000,000 ft. of conduit per month. It is supplying the Pennsylvania tunnels, the McAdoo tunnels, the New York subway loop connecting the Brooklyn and Williamsburg bridges and the Brooklyn subway, with all the electrical conduit, as well as with the clay blocks used for lining the sides of the tunnels to render them moisture-proof. Its orders for this latter material alone have run over 1,000,000 sq. ft. This company has also supplied all the sewer pipes for the Pennsylvania tunnels. The securing of these large contracts is a tribute to the enterprise of this company as well as to the merits of its product.

STOKERS FOR BROOKLYN PLANT.—Just at the close of 1907, one of the largest orders ever placed for mechanical stoking equipment was received by the Westinghouse Machine Company, aggregating 14,400 boiler hp. This was for one of the large Brooklyn power stations operated by the Transit Development Company, New York. This order comprises 24 stokers suited to 600-hp boilers of the Babcock & Wilcox water tube type. Moreover, this is the second large order placed by this company for Roney stokers, and may be regarded as the direct result of a year's successful operation of the original 7200-hp installation at the Kent Avenue station. This station was originally equipped with flat grates for hand firing.

RUBBER IMPORTS.—Crude rubber imports for the nine months ended March, 1908, amounted to only $26,000,000, against $45,500,000 in the corresponding months of the preceding year and $33,750,000 in the corresponding months in 1906, and yet the quantity imported was more than 42,000,000 lb., against 58,000,000 lb. in the corresponding months of the previous year and 43,500,000 lb. in the corresponding months of 1906.

DOSSERT & COMPANY, 242 West Forty-first Street, New York, have received orders from Walter Kidde for 2-way connectors, cable taps and terminal lugs for use in the wiring of the plant of the American Hard Rubber Company, College Point, L. I. Mr. Kidde states that he will hereafter discard all soldered connectors and use only Dossert connectors and terminals on all panel boards, generators and wiring of every description installed by him.

LARGEST AIR-BRAKE CONTRACT ON RECORD.—It is reported from Milwaukee, Wis., that the National Brake & Electric Company of that city has closed a contract to manufacture 12,000 air-brakes for the Chicago Railways Company. The outlay involved is more than $100,000, and the contract is said to be the largest of its kind as yet recorded.

POWER PLANT IN SHENANDOAH VALLEY.—Due to a constantly increasing business ever since the power plant of the Winchester & Washington City Railway Company, of Winchester, Va., was put in operation some two years ago, it has been found necessary to double the output by the installation of two more hydro-electric units. The executive offices of the company are located in Winchester, Va., while the power plant is in the famous Shenandoah Valley at Millville, 28 miles northeast of Winchester. The power house is substantially constructed of concrete and brick, with provision made for four waterwheel and four generating units. The initial equipment consisted of two units of 45-in. Sampson wheels complete, with rope-drive to Westinghouse generators located on the floor above the wheel pits. The two new units for which contracts have just been placed, and which are expected to be ready for operation during the coming summer, will consist of "Improved New American" turbines built by the Dayton Globe Iron Works Company, Dayton, Ohio. Each unit will consist of a pair of 49-in. turbines mounted horizontally and enclosed in a steel flume 12 ft. 6 in. in diameter which will connect to the thimble now built in the bulkhead wall. The turbine shaft will extend through the flume head cover on the down-stream end of the unit, and be supported by heavy ring oiling bearings upon cast-iron bridge-trees spanning the foundation I-beams. Each pair of wheels will develop 1000 hp and 150 r.p.m. under 22 x 6 in. working head, and the power will be transmitted to the generators above through a rope drive, built by the Dodge Manufacturing Company, Mishawaka, Ind. The driving sheaves will be 132 in. diameter, and the driven sheave 55 in. diameter, with grooves for 30 1½-in. ropes. The generators will be 500-kw capacity, each running 360 r.p.m., and will be Westinghouse alternators. The shafts and bedplates are to be extended for rope drive. Mr. S. H. Hansbrough, of Winchester, Va., is president of the Winchester & Washington City Railway Company, and the power plant, with its hydraulic and electric equipment, is under the supervision of Mr. S. M. Swink.

LARGE GAS ENGINES.—Allis-Chalmers Company is shipping out and installing large blast-furnace gas engines, weighing 1,500,000 lb. each, at the rate of three per month. These are principally for the United States Steel Corporation for its several plants at Pittsburg, Pa.; Chicago, Ill.; Cleveland, Ohio, and Gary, Ind. A number of these engines have already been in commercial service and are giving highly satisfactory results, fulfiling the most sanguine expectations of the builders and purchasers. The Allis-Chalmers Company has been more fortunate than almost any other large industrial company in that it was last year favored with a large volume of work for 12 to 18 months' delivery, including mining and crushing machinery for domestic and foreign purposes, also pumping machinery for various municipalities throughout the country, as well as the immense gas-engine orders from the steel corporation. It is stated by an official of that company that at this date it has nearly a year's work ahead of its West Allis and Chicago plants. The company also announces a gradual but steady improvement in its bookings of new orders for steam turbines and its smaller lines of electrical apparatus. It is also receiving at the present time a very satisfactory volume of business for their standard products in mining, rock-crushing and flour-mill machinery. It reports marked activity in the way of new inquiries. These are well distributed from all parts of the country and indicate that a great many of the industrial and electric lighting and power companies' plans made for extensions previous to the recent financial depression have again been taken up actively for completion.

NANKAI RAILROAD EQUIPMENT.—A second order of cars has been placed for the Nankai Railroad in Japan, on which the motive power was changed from steam to electricity about two years ago. This order is for 12 electric car equipments, capable of operating at a speed of about 55 miles per hour. All the parts, except the car bodies, which are to be built in Japan, will be imported from this country. The outfit consists of 12 Westinghouse quadruple, No. 101 H, 500-volt direct-current, railway motor equipments with unit-switch control, and 12 Westinghouse schedule S. M. E. straight air-brakes, including the emergency feature, and arranged to be operated from both ends of each car. The order includes 12 pairs of Brill 27 E. I. trucks, complete with standard equipments, with wrought-iron center and steel-tired wheels. The entire contract was placed by Takata & Company, of Tokio, London and New York. The original installation, which was put in place by Takata & Company in 1906, consisted of two Westinghouse 500-kw, 600-volt, engine-type generators, driven by two McIntosh & Seymour compound, side-crank engines. A complete switchboard outfit was also erected. The original equipment consisted of 25 motor cars with 25 pairs of Brill 27 G. E. I. type, substantially the same as the new order mentioned above. A complete system of automatic signals made by the General Railroad Signal Company was installed at that time, to be used in connection with both the electric and the steam service.

THE YOUNGSTOWN SHEET & TUBE COMPANY, Youngstown, Ohio, has lately placed a contract with Allis-Chalmers Company, Milwaukee, for three large motor generator sets intended for operation in connection with two 1500-kw Allis-Chalmers steam turbines and generators ordered some time ago. The equipment will also include two induction motor exciter sets, a balancer and transformers of the oil-filled self-cooled type. The main motor generator sets each comprise 500-kw 250-volt direct-current generators and 750-hp, 6000-volt, 25-cycle motors. This addition will give the plant electric current for lights, crane operation, furnace skip, etc. The added power, to provide which practically a new power house was required, was rendered necessary by the erection of two new blast furnaces. One of the turbines is designed to operate condensing and one non-condensing, with steam pressure of 150 lb. per square inch. The exhaust from the non-condensing turbine is to be utilized for heating boiler feed water in an open-type heater. Mr. Julian Kennedy, of Pittsburg, Pa., acted as consulting engineer.

CONTRACT BETWEEN WESTERN ELECTRIC COMPANY AND NEW ENGLAND TELEPHONE COMPANY.—Out of 32 operating companies of the American Telephone Company, 26 are now working under the system of having the Western Electric Company act as its purchasing agent, a contract making such an arrangement having been signed recently between the Western Electric Company and the New England Telephone Company. The Western Electric Company, under the terms of the contract, receives 2 per cent for handling general supplies furnished the telephone companies, but only on the condition that the total price to the telephone company, with the 2 per cent commission added, does not exceed the price the telephone company would pay if it purchased these same goods at the most favorable terms in the open market. This arrangement is said to be made solely in the interests of and is expected to save the Bell companies hundreds of thousands of dollars annually.

SALES OF INSULATORS.—Mr. Louis Steinberger, of the Electrose Manufacturing Company, informs us that he has had some very large orders lately. Five thousand standard insulated bolts, 7500 standard insulated spools and 50 bronze Brooklyn strain insulators have been sold through the Western Electric Company to the Chicago City Railway Company. This is the largest insulator order of its kind ever given out in Chicago, and was secured in the face of sharp competition and after severe tests and experiments lasting a year. This order was accompanied by one from the city of Chicago itself for 500 Electro insulators with malleable-iron pins and 300 Electrose insulators for high-tension arc-lighting work. Many thousands of these will be required and used during the year.

WESTINGHOUSE ELECTRIC COMPANY BUSY.—The Westinghouse Electric & Manufacturing Company obtained an order last week for 150 electric motors for the Washington Railway & Electric Company, of Washington, D. C., which will be used to equip cars on the lines of that company now in operation. Work on this order has been begun. Officers of the company state that a large number of small contracts are coming in, and these, added to the amount of work pending, will, in all probability, keep the plant at East Pittsburg in fairly active operation throughout the summer.

J. G. WHITE & COMPANY, Inc., of New York, have been awarded the contract for engineering and constructing a complete hydro-electric plant, with transmission lines, substations, etc., for the Central Georgia Power Company. This plant will be built on the Ocmulgee River, about 36 miles above Macon, Ga., supplying power to that point and to other points in the vicinity. The normal capacity of the plant will probably be 12,500 kw, generated by water wheels under 100-ft. head. The crest of the dam will probably be 750 ft.

Financial Intelligence.

THE WEEK IN WALL STREET.—Although with less vigor, and at times weakening somewhat on profit taking, the market continued bullish last week, with little apparently in sight to justify its advances. The present rise is conceded to be the result of manipulation, and is thought by many to have been engineered in order to create a favorable sentiment in the bond market, an end which has certainly been attained, but it is pointed out by those optimistically inclined, that no matter how manipulative a market may be for the moment, it indicates in the long run the trend of events in the business world. The uncertainty of the $100,000,000 bond issue of the Union Pacific Railroad tended to keep matters quiet until Mr. Harriman announced that it was planned to place only $50,000,000 of bonds at this time, and then there was a moderate reassertion of strength. The announcement that the control of the smelting interests still rests with the Guggenheims, and that affairs are harmonious among the copper interests, gave firmness to those securities. The sale of the Interborough 6 per cent notes so as to yield a bid of 2¾ per cent to members of the underwriting syndicate is calculated to draw money from out of the hidden places more quickly than any other inducement. On Friday the government published its customary monthly report on the conditions of crops, which announced that the prospective yield of the winter wheat is 467,000,000 bushels, a gain of 56,000,000 bushels over the prospective yield at this time a year ago. The New York City banks returned to the United States Treasury during the week $15,000,000 of the $20,000,000 of government deposits recalled at this time. In spite of this withdrawal and the heavy financing done during the week, the money market remained easy and showed signs of continuing to do so. There is a great accumulation of money in all the financial centers of the world, with the exception of Germany and Japan, which keeps rates down, and will, in the end, make it comparatively easy for merchants to obtain funds to carry on their business. The transactions in the market on Monday were the largest for more than a fortnight, totaling more than 1,000,000 shares. Closing prices were as follows:

NEW YORK.

	May 4	May 11	Shares Sold.		May 4	May 11	Shares Sold.
All-Ch.	8¼	8	500	Int-Met., com.	9⅞	11¾	6,920
All-Ch., pfd.	20⅝	21½	2,900	Int-Met., pfd.	27½	31⅜	5,200
Amal. Cop.	60⅜	63⅞	203,700	Mackay Cos.	61½	63	1,000
Am. D. T.	39*	39*	———	MackayCos.,pfd.	65¾*	64	1,600
Am. Loc.	47⅜	50½	43,405	Met. St. Ry.	25*	29	50
Am. Loc., Pfd.	99½	102*	1,015	N.Y. & N.J. Tel.	108*	105*	14
Am. Tel. & C'bl.	50*	50*	———	Steel, com.	35⅜	37⅛	189,452
Am. T. & T.	117½	117½	1,550	Steel, pfd.	100¾	102⅛	28,632
B. R. T.	46⅛	50¾	41,245	W. U. T.	50¾	51¼	615
Gen. Elec.	133	137	2,500	West'h, com.	48	47	5,365
Hud. R. Tel.	—	—	———	West'h, pfd.	64*	60	1,000

PHILADELPHIA.

	May 4	May 11	Shares Sold.		May 4	May 11	Shares Sold.
Am. Rys.	44⅜	44⅜	———	Phila. Elec.	8½	8¾	———
Elec. Co. of Am.	9⅞	10	———	Phila. R. T.	18	18¼	———
Elec. Stor. B'ty.	30	32¼	———	Phila. Traction.	89	91	———
E. S. B'ty, pfd.	—	—	———				

CHICAGO.

	May 4	May 11	Shares Sold.		May 4	May 11	Shares Sold.
Chicago City Ry.	160	160	———	Met. Elec., com.	17	19	———
Com. Edison.	91½	91¾	———	Met. Elec., pfd.	46	49	———
Chicago Subw'y.	—	—	———	National Carbon.	57½	61¼	———
Chicago Tel. Co.	118	118¾	———	Nat. Carbon pfd.	110	107½	———

BOSTON.

	May 4	May 11	Shares Sold.		May 4	May 11	Shares Sold.
Am. Tel. & Tel.	117¼	117½	———	Mass E. R., pfd.	44	44	———
Comb'ind Tel.	—	109¾	———	Mex. Tel., pfd.	5⅝	—	———
Edison El. Ill.	—	214	———	New Eng. Tel'p.	113½	113¾	———
Gen. Elec.	134	137½	———	W'st Tel. & Tel.	—	6¼	———
Mass. Elec. Ry.	10	9¾	———	W. T. & T., pfd.	65	65½	———

*Last price quoted.
Shares sold are for week May 3-9.

THE WEEK IN COPPER.—A sagging copper market in London, coupled with no appreciable improvement in home demand during the last week, intensified the dulness which has existed for some time in the copper trade and caused the outlook to be viewed with increasing gloom. Vigorous efforts were made by some of the larger interests to bolster up the market, but met with little success. Those who hold optimistic views declare that while the buying at present is 50 per cent or less than normal, there are many indications that at least 90 per cent of the consumers have used up their available supplies and are ready to enter the market at a moment's notice. They back their views by pointing to the slight increase in demand which was noticeable at the beginning of this week. Other authorities on the metal trades refer to the over-stocks of metal abroad, the belief that there is little chance for a marked improvement in home consumption for some months to come, the increased production which will be dumped on the market in June, and predict 12-cent copper. The statement that the coming output of the Butte mines has already been contracted for is not taken literally. Whatever the outcome may be it is certain that the market is being held only with the greatest effort under existing conditions. Closing prices on the Metal Exchange, Monday, were as follows:

Lake	12½ @ 12¾
Electrolytic	12⅜ @ 12⅝
Castings	12⅛ @ 12⅜

STOCKHOLDERS RATIFY $50,000,000 BOND ISSUE.—The proposed $50,000,000 bond issue by the Public Service Corporation of New Jersey, which was noted in these columns, was authorized at a meeting of the stockholders on May 5. Of the issue, $3,725,000 are to be delivered by the trustee, the Fidelity Trust Company of Newark, to the corporation to recoup the company for improvements made recently and $7,250,000 are to be reserved for retiring at par, a like amount of collateral gold notes, dated Nov. 1, 1904, and $6,250,000 reserved to retire that amount of convertible notes issued by the company under date of April 16, 1906. After the delivery of the first instalment of $25,000,000 it is provided that no further bonds can be certified and delivered by the trustee until the officers of the company certify that the earnings of all the property mortgaged and the income from the securities pledged for 12 months preceding exceed by 33 1/3 per cent the interest on all bonds issued under mortgage. Of the remaining $25,000,000, the certified earnings must exceed the interest by 50 per cent.

PACIFIC CORPORATION SHARES LISTED.—The preferred and common stocks of the Pacific Lighting Corporation have been listed on the San Francisco stock and bond Exchange. There are 41,620 shares of preferred, par $100, and 48,000 common shares, $20 par, issued. The Pacific Lighting Corporation was organized last year to succeed the Pacific Lighting Company, with a capital of $20,000,000 in 200,000 shares of a par value of $100 each. There were issued 100,000 shares of preferred stock and 100,000 of common stock, of which 40,000 common shares were exchanged for 40,000 common shares of the old corporation and 40,000 shares of preferred stock in exchange for 40,000 preferred stock of the old company. The new company owns the entire capital stock of the Los Angeles Gas & Electric Company, 98 per cent of the stock of the Pasadena Consolidated Gas Company, $997,000 par-value bonds of the Los Angeles Gas & Electric Company, Pasadena Consolidated Gas Company and Eureka Lighting Company, and owes $480,000 in time loans.

WASHINGTON RAILWAY & ELECTRIC.—The annual report of the Washington Railway & Electric Company, of Washington, D. C., for the year ended Dec. 31, 1907, shows a gross income of $3,385,748, as compared with $3,133,240 for 1906. Expenses were $1,748,752, as compared with $1,613,096 for 1906, leaving a net of $1,636,996, against a net of $1,520,144 for the previous year. The total income was given as $1,679,349, as against $1,564,739 for the previous year and a total surplus of $572,121, against a total surplus of $523,621 for 1906. Deducting preferred dividends of $425,000 and fixed charges of $52,700 from the total, left a profit-and-loss surplus for 1907 of $832,382. The surplus for the year of $572,121, as given above, is equal to 5 per cent earned on the $8,500,000 preferred stock and 2.26 per cent on the $6,500,000 common stock.

BROCKTON EDISON COMPANY BONDS.—The banking firm of Perry, Coffin & Burr, of Boston, are offering $100,000 first mortgage, 5 per cent gold bonds of the Edison Electric Illuminating Company, of Brockton, Mass. The issue is dated Dec. 1, 1900, and is due Dec. 1, 1930, redeemable all or in part on any interest date at 110 and interest. The company has a capital stock of $800,000 and a funded debt of $265,000. Net earnings for the year ended Feb. 29, 1908, were $85,626, equaling eight and one-half times the annual interest on the entire first mortgage bond issue, including the $100,000 bonds just issued and now offered.

HUDSON RIVER CO.—The Hudson River Power Company report for the quarter ended March 1 shows gross earnings of $324,555, as compared with $256,959 for the same period last year, and expenses of $159,918, as compared with $155,246 for the corresponding quarter in 1907. The net for the three months was $164,637, against a net of $101,713 for 1907, and the net for the twelve months was $549,125, as compared with a net of $369,213 for the previous twelve months.

WORK OF THE WESTINGHOUSE COMMITTEES.—The following letter explaining the relations between the Merchandise Creditors' Committee and the Westinghouse interests has been issued by Mr. George M. Verity, secretary of the Merchandise Creditors' Committee: "Many creditors do not understand the exact relation of the Merchandise Creditors' Committee to the Westinghouse Electric & Manufacturing Company and some of them seem to be under the impression that the members of the committee are persons connected either directly or indirectly with the company. No member of the committee is connected either directly with any of the Westinghouse companies or interested in any of them in any way save as a creditor. Each member of the committee represents one of the largest merchandise creditors and their claims aggregate $1,700,000. Mr. Joseph Marsh, chairman of the committee, is vice-president of the Standard Underground Cable Company, of Pittsburg, Pa.; Mr. F. W. Roebling is treasurer of the John A. Roebling's Sons Company, of Trenton, N. J.; Mr. C. R. Remington is secretary of the American Electrical Works, of Phillipsdale, R. I.; Mr. A. Bournonville is a member of the firm of Alfred F. Moore, of Philadelphia, Pa., and Mr. Geo. M. Verity, secretary of the committee, is president of the American Rolling Mill Company, of Middletown, Ohio. These gentlemen being interested in the Westinghouse Electric & Manufacturing Company as large creditors are naturally well informed on the general character and scope of the Electric Company's business. They are working in the interests of the merchandise creditors of which they represent so large a part, and entirely independent of the company. They desire to preserve both the integrity of their claims and that of the Westinghouse Electric & Manufacturing Company as an industrial factor, and believe that this much-desired result can be accomplished through the consummation of the plan proposed by them for a readjustment of its financial interests without either a sale or a drastic reorganization. "Claims of the merchandise creditors to the extent of $3,750,000 have been signed or promised," said Mr. Verity, "out of $4,000,000 guaranteed and a possible total of $4,250,000. We are doing our part, and it is up to the stockholders to do theirs. Certainly it would seem that they have more at stake than the creditors, as we would have a prior claim on the assets in case the plan was not carried out. It does not seem likely, however, that any one would be so shortsighted as not to subscribe his pro rata share to save his holdings in a company whose minimum net earnings are more than enough to pay the fixed charges on all the capital stock, including the new issue, and whose maximum earnings may and will without question, in prosperous times, exceed the fixed charges by from 15 to 20 millions. One feature that has not been touched upon to any extent but which will be a distinct advantage to the company, is the fact that the issue of the 'assenting' stock will mean at least 1500 new stockholders, one might almost say an additional sales force of 1500 working in the interests of the company." The Stockholders' Committee will have until June 1 to carry out its share of the programme. "Out of 3700 stockholders 900 have subscribed for their pro rata amount of the new stock at the rate of one share of the new stock for every four shares held," said the secretary of that committee, "and the returns continue to come in satisfactorily. The circular issued by Mr. Westinghouse evidently stirred them up to a realization of the necessity of their co-operation. In a few cases where it was impossible to raise the necessary money, stockholders sent regrets and of course there is the usual number of persons holding stock who are abroad and cannot be reached immediately, and also stocks tied up in estates and trusteeships, all of which requires time to bring into line. The committee has evolved a new plan to reach large stockholders, and it is confidently expected that by June 1 the requisite amount of subscribers will have been obtained." The National Shawmut Bank, of Boston, has been appointed by the Stockholders' Committee as an additional depositary to receive payments for the new stock on which subscriptions are payable as follows: 25 per cent May 25, 20 per cent Aug. 1, 20 per cent Nov. 1, 20 per cent Jan. 1, 1909, and 15 per cent April 1, 1909. A committee has taken charge of the Security Investment Company, of Pittsburg, with a view to safeguarding the interests of the creditors of the Security Investment Company. The committee proposes to extend all notes and raise $3,000,000 through the sale of more obligations to protect the Westinghouse Electric stock, now held as collateral in loans. This committee strongly indorses the merchandise creditors' plan. By order of United States Judge Cross sitting in Trenton, N. J., the receivers of the Atha Steel Casting Company, Benjamin Atha, Ernest F. Harder and George W. Hebard, will accept $61,000 of the stock of the Westinghouse Electric & Manufacturing Company in discharge of the merchandise liability of the Westinghouse Company to the Atha Company. The claim against the Westinghouse Company was for work done and represented 45 per cent of the entire business of the Atha Company. Under an agreement between the two companies the Atha Company is to get the Westinghouse Company's business when the reorganization is completed, which will rehabilitate the Atha Company.

MASSACHUSETTS ELECTRIC COMPANIES.—The report of the Massachusetts Electric Companies for quarter ended March 31, 1908, shows gross earnings of $1,552,171, as compared with $1,526,523 for the same month in the previous year. Operating expenses were $1,127,120, against $1,207,781 for the first quarter of 1907. Net earnings were $425,051, against $318,741 for the period in comparison in 1907. Deducting taxes and charges of $464,316, left a deficit of $39,265, a marked decrease from the deficit for the same time in 1907, which was $117,411. The gross earnings for the six months were $3,332,246, against $3,241,142 for the same six months in the preceding year and net earnings were $884,463, against $804,553, for the corresponding six months of the previous year. The deficit for the six months is given as $16,289, as compared with a deficit of $41,890 for the same six months in 1907. In 1906, for the six months there was a surplus of $34,262.

STOCK AND BOND ISSUES AUTHORIZED.—The Gas Commission has authorized the Lowell (Mass.) Electric Light Corporation to issue $93,000 in additional stock at $1.50 per share, the proceeds to be used to cancel outstanding notes. The Gas Commission has authorized the Edison Electric Illuminating Company, of Brockton, to issue $100,000 5 per cent 30-year, first mortgage bonds, the proceeds to be used to cancel outstanding promissory notes. Subscriptions to the 1950 shares of new stock of the Lynn Gas & Electric Light Company, recently authorized by the Board of Gas & Electric Light Commissioners, will close on May 6. Of the $3,962,200 additional stock issue of the New England Telephone Company, rights to which expired April 16, it is reported that more than 95 per cent has been taken.

PLATTSBURG LIGHT, HEAT & POWER.—A $250,000, thirty-year, 5 per cent bond issue by the Plattsburg Light, Heat & Power Company has been authorized by the Public Service Commission of the Second District, New York State. The company is permitted to put out $230,000 of the bonds at the present time, and the issue is secured by a mortgage to the Standard Trust Company of New York upon all of the company's property. Of the issue, $65,000 must be sold at not less than 90, to take up the company's floating indebtedness, while $25,000 must be sold at not less than 90, to be used in making extensions and improvements to the gas-distributing system.

ROCHESTER RAILWAY & LIGHT.—The Rochester Railway & Light Company has been authorized by the Public Service Commission of the Second District, New York State, to issue 5 per cent consolidated mortgage bonds at par to an amount not exceeding $1,637,000, which must be sold at not less than 90. The bonds are redeemable at 103 under mortgage dated June 15, 1904, securing a total issue of $16,000,000. The proceeds of this additional issue are to refund outstanding obligations to the amount of $1,474,000.

CENTRAL & SOUTH AMERICAN TELEGRAPH.—The Central & South American Telegraph Company, in its annual report for the year ended Dec. 31, 1907, gives a gross income of $1,749,045. Expenses were $556,666 and the net of $1,192,379 is equal to 11.9 per cent of the $10,000,000 of capital stock. Dividends of $551,031 were declared, leaving a balance of $641,348. Adding the surplus of $607,936 to the previous surplus gives a total surplus of $2,478,386, as compared with $1,870,450 for 1906.

MEXICAN TELEGRAPH COMPANY.—The Mexican Telegraph Company, in its annual report for the year ended Dec. 31, 1907, gives total receipts of $1,047,531, with total deductions of $182,163, leaving net earnings of $865,368, equal to 30 per cent on the $2,879,100 of capital stock outstanding. Dividends of $287,010 were declared, leaving a surplus of $578,358 which, added to the previous surplus, gives a net surplus for the year of $2,381,895.

GENERAL NEWS

Late items are printed unclassified at end of department

Construction News.

SHEFFIELD, ALA.—The power project of the Muscle Shoals Power & Development Company has been approved by the Inland Waterways Commission at Washington, D. C. It is proposed to make another survey of the bed of the Tennessee River before the exact location of the dam is determined. Representative Richardson states that Congress, at the next session, will appropriate the necessary money which, with the co-operation of the Muscle Shoals company, will complete the project.

DANVILLE, ARK.—The electric light plant owned by A. Pace has been put in operation and is now furnishing electricity for lighting the town.

BERKELEY, CAL.—J. V. Mendenhall, town clerk, writes that the citizens voted against the proposition to issue bonds to establish an electric light plant in connection with an incinerating plant, for which the proposition to issue bonds was also defeated.

NEVADA CITY, CAL.—The machinery at the new power plant on Deer Creek of the Pacific Gas & Electric Company has been started, the station being placed in regular service on the company's long transmission system to San Francisco and Oakland. About 8000-hp can be developed.

REDDING, CAL.—It is reported from Heroult-on-the-Pitt that the electric iron smelter of the Noble Steel Company is to be considerably enlarged. The present furnace is to be replaced immediately by one several times as large. Construction work has already been commenced. The furnace will be about eight feet high, and the experiment will be carried on with three-phase current. Prof. Lyon, of Stanford, has the experiment in charge.

SAN BERNARDINO, CAL.—An independent telephone company has been organized in this city. The incorporators are: P. S. Hamer, M. E. Foulke, A. L. Streeter and others.

SAN BERNARDINO, CAL.—The Board of Supervisors has granted A. G. Hubbard, of Redlands, a franchise for an electric railway in this place. It is proposed to extend the Redlands Central Railway toward Redlands Junction.

SAN FRANCISCO, CAL.—The City Electric Company is now selling nearly all of its output to the United Railroads. The company is planning to install a 6000-kw Westinghouse generator in its plant.

SAN FRANCISCO, CAL.—The United Railroads has placed a contract with the General Electric Company for a Curtis steam turbine direct connected to a 5000-kw General Electric, three-phase, 13,200-volt generator to be installed in the North Beach power house. It is stated that an increase in the boiler plant will be necessary.

DANIELSON, CONN.—The Danielson Cotton Company has purchased a tract of land in Pomfret Landing, where it will build a large dam to secure water power to operate its manufacturing plant. The company also contemplates the construction of another large mill in Danielson, which will be operated by electrical power generated at the Pomfret Landing plant.

HARTFORD, CONN.—The Railroad Commissioners have approved the proposed route and construction of the electric railway which the Connecticut Company is to build between Hartford and Middletown.

WILLIMANTIC, CONN.—The Willimantic Gas & Electric Company is installing an electric pump at the engine house of the New York, New Haven & New York Railroad Company to operate the water supply for the engines by electricity, instead of steam power.

SMYRNA, DEL.—The Diamond State Rapid Transit Company is contemplating the construction of a power plant to be located at St. Georges, plans for which, it is said, are being prepared by John D. Thompson, of Wilmington.

WASHINGTON BARRACKS, D. C.—Bids will be received until May 27, by Lieut. W. H. Rose, Quartermaster, U. S. A., for furnishing and laying primary and secondary electric cable at this post.

ADRIAN, GA.—The Adrian Power Works, recently incorporated, contemplates the construction of an electric light plant, water supply and ice plant. W. W. Strickland, of Adrian, is president and manager.

JACKSON, GA.—The Central Georgia Power Company has awarded the contract for the construction of its hydro-electric plant on the Ocmulgee River, near Jackson, 35 miles from Macon, to J. G. White & Company, of New York, N. Y. The contract includes the construction of hydro-electric plant, transmission lines and substation. The plant will have an output of about 12,000 kw and will furnish electricity in Macon and other points in that vicinity. Charles F. Howe, Grand Building, Macon, Ga., is chief engineer of the Central Georgia Power Company.

ROME, GA.—The town of Rome is reported to have about reached an agreement with the Rome Railway & Light Company to furnish lamps for another year at $65 per lamp, against $84 formerly paid by the town. The company proposes to maintain about 200 lamps and to sell electricity for lamps for private use at 10 cents per kw-hour and for motors at half that rate.

STATESBORO, GA.—The Statesboro Telephone Company is planning to erect about 7500 ft. of aerial cable, and would like to receive estimates for the cost of the material and also the cost of erecting the same.

CLINTON, ILL.—The Wasson Telephone Company is planning to rebuild its old lines and the erection of a number of new lines.

LA SALLE, ILL.—Plans are being considered by seven of the largest independent telephone companies in northern Illinois to incorporate a local company to install a system at La Salle and Peru, at a cost of $100,000, which would have toll connections with the Illinois companies included in the International Independent Telephone Association.

PRINCETON, ILL.—Extensive improvements and extensions are contemplated by the Independent Telephone Company, including the construction of a new copper toll line to Spring Valley and Ladd.

BURKET, IND.—Plans are being considered for the organization of a telephone company here. Gilbert Alexander, E. S. Vandemark and T. L. Blue are interested in the project.

MT. VERNON, IND.—The City Council has granted a franchise for the construction and operation of a lighting plant in this city to S. C. Goodrich and J. G. Heesler, of Flint, Mich.

RED KEY, IND.—An election will be held to vote on the proposition of issuing $12,000 electric light bonds.

TIPTON, IND.—Ex-Senator Osborn, of New Castle, has petitioned the City Council of Tipton for a franchise to construct, equip and operate a lighting plant.

CLINTON, IA.—Plans are being made by the Iowa Telephone Company for extensive improvements and extensions to its local plant, which will involve an expenditure of about $150,000.

MASON CITY, IA.—The Western Telephone Company contemplates extensive improvements to its system, among which is the construction of a telephone line between Rock Rapids and Estherville. The cost of the work is estimated at $100,000.

OSKALOOSA, IA.—The Home Telephone Company contemplates extensive improvements to its plant in this city, the cost of which is estimated at $50,000.

COFFEYVILLE, KAN.—Surveys are now being made of the route of the proposed railway of the Kansas Traction Company. The road will extend from Coffeyville to Lawrence, branching at that place to Kansas City and Topeka, and will be about 200 miles in length. The main power plant will be located in the natural gas field. The third-rail system will be used.

PRATT, KAN.—S. S. Smith, proprietor of the Pratt electric light and ice plant, which has been purchased by a syndicate of local capitalists, it is reported, has awarded a contract for the construction of a new plant at a cost of $25,000.

CLINTON, LA.—The city is contemplating the purchase of the local electric light and ice plant to be operated by the municipality. A committee, consisting of John Levy, W. J. Sebastian and I. L. Heyman, has been appointed to investigate the matter.

NEW ROADS, LA.—The Town Council is contemplating the establishment of an electric light plant in conjunction with the water works plant.

BRIDGTON, MAINE.—The Bridgton Center Village Corporation has entered into a contract with the Bridgton Water & Electric Light Company for lighting the streets of the village one year. Under the terms of the contract the village is to pay $10.75 for incandescent lamps of 32 cp, which is an advance of 75 cents over the former contract.

BALTIMORE, MD.—The United Amusement Company, lessees of Electric Park, has entered into a contract with the Consolidated Gas, Electric Light & Power Company for electricity for lighting the park. The contract calls for electricity for 40,000 incandescent lamps. Electrical energy for the system will be supplied from the Westport power house. A substation will be erected in the park. Max Rosen is manager of the park.

BERLIN, MD.—The City Council will receive propositions until May 20 for furnishing the city with electric light and water, the city to have the option of purchasing the plants at the end of 5, 10 and 15 years at a price a committee may fix. Orlando Harrison is mayor.

SWALLOWS FALLS, MD.—Plans are being considered by the Swallows Falls Electric Light & Power Company for the construction of an electric power plant at Swallows Falls, and also contemplates the construction of an electric railway between Oakdale and Swallows Falls, a distance of about eight miles. H. P. Tasker, of Oakland, is interested in the project.

CLINTON, MASS.—A substation will be built by the Connecticut River Power Company near the Lancaster Mills, from which the electrical energy received from the company's plant at Vernon, Vt., will be distributed in Clinton.

FITCHBURG, MASS.—Thirty grants of perpetual rights of way have been recorded at Worcester North, registry of deeds, for the Connecticut River Power Company, which is seeking to enter Fitchburg to furnish electricity for motors. The grants include right to erect and maintain a

double transmission line across land in Westminster, Leominster and Fitchburg, connecting at Westminster with lines direct to power stations near Brattleboro, Vt.

HAVERHILL, MASS.—The State Board of Gas and Electric Light Commissioners has authorized the Haverhill Electric Light Company to issue 1,145 additional shares of capital stock to be offered to the stockholders at not less than $130 a share.

SOUTHBRIDGE, MASS.—The Southbridge and Webster Gas & Electric Company is making arrangements to operate the Southbridge electric system from the Webster plant, and as soon as the transmission line is completed the company will furnish a 24-hour service in Southbridge. For the present the local plant will be kept in operation.

WESTFORD, MASS.—The citizens are considering the question of lighting the streets of the town.

WILLIAMSBURG, MASS.—The Massachusetts Lighting Companies has resumed negotiations for the purchase of the property of the Mill River Electric Light Company, which furnishes electricity in Williamsburg and Haydenville. If the Massachusetts company takes over the plant, electrical energy for operating the system will be furnished from the station of the Northampton Electric Lighting Company, at Northampton, which is owned by the company, and a 24-hour service will be given.

WILLIAMSTOWN, MASS.—The Williamstown Gas Company is making arrangements to extend its transmission lines from the Henderson Road to the Sand Springs.

ESCANABA, MICH.—The hydro-electric power plant of the Escanaba Pulp & Electric Company at Flatrock will be put into commission in July. The plant will have an output of 1200 hp and will supply electrical energy to the city of Escanaba and also to the Escanaba Electric Street Railway Company, for which contracts have already been placed. The plant cost approximately $80,000.

GOODWELL, MICH.—An independent telephone company has been organized in this city and the following named officers elected: C. H. Kenshol, president; John Fairchild, secretary, and Gabe Burket, treasurer.

MENOMINEE, MICH.—The Menominee & Marinette Traction Company is contemplating the purchase of the Holmes interest in the Grand Rapids water power, two miles east of Ingalls. The capital stock of the company has been increased to $1,000,000. It is said that work will commence in June on the construction of the power house and dam.

PLAINWELL, MICH.—The Commonwealth Power Company contemplates the construction of a dam about one mile below Plainwell, at a cost of about $50,000.

ELLSWORTH, MINN.—A franchise has been granted to Fred M. Sadler to construct and operate an electric light plant in this town.

MONTICELLO, MINN.—The Mississippi River & Electric Power Company has been granted permission by the War Department, Washington, D. C., to construct two dams on the Mississippi River, one at Monticello and the other near Clearwater. Under its charter the company is authorized to transmit electricity to nearby cities and towns, and to construct and operate electric railways. The company owns right of way from Monticello to the southern limits of the city of St. Cloud, on both sides of the river.

FARMINGTON, MO.—The Commercial Electric Supply Company, of St. Louis, has been awarded the contract for the construction of the municipal electric light plant, for $23,120. Thomas B. Carter is engineer.

NEVADA, MO.—We are informed that the Freeborn Engineering & Construction Company, of Kansas City, Mo., has been awarded the contract for all improvements to be made to the property of the Missouri Light & Traction Company.

WEST PLAINS, MO.—The Martin Power Company is reported to have secured a franchise to erect transmission lines for the distribution of electricity and also to erect telephone lines from West Plains to Ozark County, and will later apply for a franchise to construct a system from the Howell County line to the river, where it proposes to erect a power plant.

GENOA, NEB.—John W. Early, of Columbus, Neb., has been employed by this village as consulting engineer in connection with the construction of the new municipal electric lighting plant. The cost of the plant is estimated at $10,000.

MILFORD, N. H.—The Milford Light & Power Company has absorbed the plant and holdings of the Milford Electric Light Company, and will make extensive improvements, including the installation of another 500-hp engine, dynamos, and additional transmission lines.

LITTLE FALLS, N. J.—A special election will be held June 2 to vote on the proposition to establish a lighting district.

PARK RIDGE, N. J.—The Borough Council has voted to appropriate $30,000 for the municipal electric light plant.

BABYLON, N. Y.—The South Shore Traction Company has applied to the Village Trustees for permission to construct and operate an electric railway on Main Street in this village.

EAST SPRINGFIELD, N. Y.—The East Springfield Telephone Company has decided to increase its bond issue from $15,000 to $75,000 and construct 25 miles of toll lines, connecting Cherry Valley, Fort Plains and Canajoharie.

FORT WOOD, N. Y.—Bids will be received until June 9 by C. C. Burnell, Constructing Quartermaster, Fort Wood, for furnishing and installing, complete, an electric elevator in Signal Corps storehouse at this post.

NEWBURGH, N. Y.—The Orange & Cronomer Lakes Power & Electric Company has petitioned the City Council for a franchise to erect transmission lines and to construct underground conduits for the transmission of electricity on the principal streets of the city. In return for the franchise the company offers to furnish the city with arc lamps at the rate of $60 per lamp per year. The city now has a contract with the Newburgh Light, Heat & Power Company for lighting the streets at a cost of $82.50 per lamp per year. M. C. Krug is president of the Orange & Cronomer Lakes & Electric Power Company.

NEW YORK, N. Y.—Bids will be received by C. B. J. Snyder, superintendent of school buildings, until May 18, for installing electric equipment in additions to and alterations in Public School No. 75, and new Public Schools Nos. 156 and 158, Borough of Brooklyn.

NEW YORK, N. Y.—The Hudson & Long Island Traction Company proposes to build an electric railway from Long Island City across the Blackwell's Island Bridge to the West Forty-second Street Ferry, Manhattan, a distance of 4½ miles. The company is capitalized at $50,000, and the officers are: F. K. Morris, president; C. M. Wicker, vice-president; Anthony Stumph, treasurer, and W. B. Spencer, chief engineer.

NEW YORK, N. Y.—Bids will be received until June 4 by James Knox Taylor, supervising architect, Treasury Department, Washington, D. C., for the installation of an interior conduit and wiring system for vacuum tube lighting in the basement of the United States Court House and Post Office Building, New York, N. Y., specifications for which may be obtained at the office of the supervising architect, Washington, D. C., or at the office of the superintendent, U. S. Custom House, New York, N. Y.

WATERTOWN, N. Y.—The Citizens' Telephone Company contemplates extensive improvements to its plant and equipment in this city, the cost of which is estimated at $100,000.

CHARLOTTE, N. C.—The contract for electrical equipment for the Chadwick, Hoskins and Louise mills has been awarded to the Westinghouse Electric & Manufacturing Company, for about $40,000. These mills are to be operated by electricity instead of steam power, energy for which will be supplied by the Southern Power Company. A substation will be erected at the mills.

HICKORY, N. C.—Plans are being prepared by Temple & Sommer, Land Title Building, Philadelphia, Pa., for the proposed electric plant of the Water Power Electric Company, which, it is said, will have an output of 3000 hp. M. E. Thornton is president.

LEAKSVILLE, N. C.—It is reported that the Leaksville Light, Power & Milling Company, recently incorporated, will install an electric light and power plant. A. B. and J. C. King are interested in the project.

SALISBURY, N. C.—The Southern Power Company has gained entrance into Salisbury, N. C., and will furnish electricity in the town. A substation is to be built jointly by the power company and the Salisbury & Spencer Railway Company at a cost of $20,000. A combination plan for distributing electricity for lamps seems to have been reached whereby the peak load will be met and the price of arc lamps greatly reduced. Numerous cotton mills will also make use of the electrical power furnished by the Southern Power Company.

THOMASVILLE, N. C.—The Thomasville Light & Power Company has established a 24-hour service in the town for both lamps and motors.

KENSAL, N. D.—Plans are being considered for the organization of an independent telephone company, which include the purchase of the local system, the extension of existing rural lines and the construction of a toll line to Carrington. L. C. Lane is interested in the project.

ASHTABULA, OHIO.—The Ashtabula Electric Street Railway Company is contemplating the construction of its proposed railway from Ashtabula to Ashtabula Junction, a distance of about 5½ miles, this year. As yet no contracts have been placed. J. V. Paulson is secretary of the company.

BUCYRUS, OHIO.—The citizens on May 5 voted to issue $90,000 in bonds for the construction of an electric light plant.

CLEVELAND, OHIO.—A franchise giving the Cleveland Electric Illuminating Company rights in a number of streets in the business section has been approved by the Board of Public Service.

CROOKSVILLE, OHIO.—It is said that the plant of the Acme Electric Light & Power Company, which was placed in the hands of a receiver, and will be ultimately sold, may be acquired by the village. The company recently built a new power house and installed a 175-hp engine. Thomas O. Crossman is the receiver.

NEW LEXINGTON, OHIO.—The capital stock of the Rushcreek Telephone Company has been increased from $10,000 to $20,000.

PIQUA, OHIO.—C. C. Custer, secretary and general manager of the Miami Light, Heat & Power Company, states that a new magnetite arc lighting system has just been installed in this city, consisting of 200 arc lamps and 125 series tungsten incandescent lamps. Two new General Electric 2300-volt three-phase alternators have also been installed. In addition, the company also operates an Edison three-wire network for lamps and motors in the commercial district. The Evans Almirall hot water heating system is operated in connection with the electric plant.

PORTSMOUTH, OHIO.—It is reported that the City Council has decided not to install a municipal electric light plant and will advertise for bids for lighting the city.

CHICKASHA, OKLA.—The Chickasha Water Power Company is installing a pair of turbine wheels with a rating of 800 hp in its hydro-electric power plant, and is also planning to install another pair of water wheels of the same rating, which will give the plant when completed an output of about 1400 hp. Lawrence Martin is treasurer.

McALESTER, OKLA.—The City Council is considering a proposition to establish a municipal electric lighting plant.

WAURIKA, OKLA.—Plans are being prepared for the construction of an electric plant, at a cost of $15,000, for which bids will be asked in about 30 days. The system will consist of 50 arc lamps of 2000 cp and 4000 incandescent lamps of 16 cp. The plant will be operated by steam power. The O'Neil Engineering Company, of Dallas, Tex., will have charge of the engineering work.

ASHLAND, ORE.—Surveys have been completed and plans made for the power plant to be erected in the Brewster Valley, at a cost of about $150,000, for which, it is said, bids for construction will be received in about 30 days. The work will include the construction of a power house, flume, reservoir and 35 miles of pipe line. E. N. Kelley, of Portland, is the designing engineer, and J. R. Benson is owner.

GRESHAM, ORE.—The Multnomah & Clackamas County Telephone Company has increased its capital stock from $5,000 to $11,000, the proceeds to be used for extending its lines to Sandy, Corbett, Eagle Creek, Damascus and other points.

PANAMA.—Sealed proposals will be received at the office of the General Purchasing Officer, Isthmian Canal Commission, Washington, D. C., until June 2, for furnishing the following supplies: Turbine pump and motor, pump governors, burners for marine boilers, power hammers, copper chain, etc. Blanks and general information relating to this circular (No. 441) may be obtained at this office or the offices of the assistant purchasing agents, 24 State Street, New York, N. Y.; Custom House, New Orleans, La.; 1086 North Point Street, San Francisco, Cal., and 410 Chamber of Commerce Building, Tacoma, Wash., and also from the U. S. Engineer Offices in the following cities: Los Angeles, Cal.; Baltimore, Md.; Philadelphia, Pa.; Pittsburg, Pa.; Boston, Mass.; Buffalo, N. Y.; Cleveland, Ohio; Cincinnati, Ohio; Chicago, Ill.; St. Louis, Mo.; Detroit, Mich.; Milwaukee, Wis.; St. Paul, Minn.; Chattanooga, Tenn.; Louisville, Ky., and Mobile, Ala. Lieut.-Col. H. F. Hodges is general purchasing officer.

CONNELLSVILLE, PA.—The West Penn Railways Company is building an extension to its system from New Salem Junction to Brownsville, to be opened by July 1. The company is constructing a new substation at New Salem Junction, which will be equipped with two 300-kw, 60-cycle, motor-generator sets, where electricity will be transformed from 22,000 volts, three-phase to 650 volts, direct current. It is also rebuilding its storage battery plant at Uniontown, and has placed an order for a 3250-kw Westinghouse turbo-generator set to be installed at the main power station at Connellsville, and is also building extensive coal bunkers and enlarging the coal-handling machinery. L. H. Conklin is general superintendent.

DANVILLE, PA.—Local capitalists are interested in a project to furnish electricity in this city for lamps and motors. An option has been secured on the Muncy dam in the west branch of Susquehanna River, where a power plant will be erected, from which transmission lines will be erected to distribute electricity in the towns between Williamsport and Sunbury.

HALLSTEAD, PA.—The Montrose Telephone Company has secured the right of way on the Hallstead side of the river to Susquehanna to erect a telephone line.

HANOVER, PA.—The capital stock of the Hanover & McCherrystown Street Railway Company has been increased from $30,000 to $200,000.

NEW WILMINGTON, PA.—The Blacktown and New Wilmington Telephone Companies are contemplating the erection of a telephone line to connect their exchanges at Balm and New Wilmington.

PHOENIXVILLE, PA.—The American Union Telephone Company contemplates issuing $30,000 in bonds, the proceeds to be used for the construction of a new telephone system in Phoenixville.

PITTSBURG, PA.—Plans are being prepared by John P. Brennan, architect, for a one and two story power house for the Department of Charities and Correction, the cost of which is estimated at $50,000.

ROYER, PA.—Plans are being considered by the Morrison's Cove Electric & Power Company for the construction of a power plant on the branch of the Juniata River near Royer. The company proposes to furnish electricity to Williamsburg, Martinsburg and surrounding towns.

WEST CHESTER, PA.—The West Chester & Wilmington Street Railway Company has increased its capital stock from $254,000 to $500,000, and will issue bonds to the amount of $500,000.

CHESTER, S. C.—The citizens on May 5 voted in favor of the proposition to issue $26,000 in bonds for extending the municipal electric light plant and water works system.

KNOXVILLE, TENN.—Plans have been prepared by Ladshaw & Ladshaw, of Spartansburg, S. C., for the French Broad River Power Company on the proposed development to be located at Pickell's Island, five miles from Knoxville. The cost of the proposed plant is estimated at $1,273,100, as follows: For dam, $299,500; power house and boat lock, $173,600; hydraulic machinery, $220,000; electrical machinery, $185,000; five-mile pole line, $105,000; substation and equipment, $165.000, and for engineering and incidentals, $125,000. The hydraulic and electrical equipment includes nine water wheels, units with a rating of 4400 hp. each; nine alternating-current generators rated at 2000 kw each; oil-cooled transformers with a rating of 35,000 kw. The output of the plant is estimated at 38,925 hp. The estimate was prepared for W. A. Boyce, of Asheville, N. C., who is interested in the project.

GEORGETOWN, TEX.—The Gravis & Corn Hill Telephone Company contemplates the construction of a new line to Georgetown.

SAN ANGELO, TEX.—A company has been organized in the city to build an electric street railway system. Among those interested in the enterprise are: E. E. Bailey, Wilbur Brown and W. T. Bartholomew.

UVALDE, TEX.—The Uvalde Telegraph & Telephone Company is considering the construction of a number of additional branch lines.

BELLOWS FALLS, VT.—The Bellows Falls Canal Company contemplates the construction of a large cement dam below the present dam during the coming summer, and is also considering the construction of another dam on the Lawrence mills property, about seven miles below Bellows Falls, which will furnish power to operate an electric plant.

EUREKA MILLS, VA.—Wood Bouldin, Jr., and J. S. Easley, of South Boston, civil engineers, have been making investigations recently with a view of establishing an electric railway from Drake's Branch to some point on the Virginian Railway. If the railway is built the towns of Drake's Branch and Charlotte Courthouse will be lighted by electricity.

WINCHESTER, VA.—Plans are being made by the Winchester & Washington Railway Company to double the output of its power plant located on the Shenandoah River at Millville, which supplies Winchester, Berryville and Charlestown with electricity for lamps and motors. Contracts for machinery have been placed with the Westinghouse Electric & Manufacturing Company and the Dayton Globe Iron Works at a cost of about $50,000.

DEER PARK, WASH.—The County Commissioners have granted a franchise to George Nixon, of Spokane, for the installation of a power plant on the Spokane River near Deer Park, which will furnish electricity for lamps and motors in Deer Park, Chattaroy and Milan. The proposed transmission line will be about 25 miles in length.

EDMONDS, WASH.—It is reported that the Stone & Webster syndicate has acquired the controlling interest in the Sander electric railway, and contemplates extending the road from Halls Lake into Everett.

EVERETT, WASH.—The Sandstone & Brick Company, of Clinton, is contemplating the construction of an electric railway between Everett and Granite Falls.

EVERETT, WASH.—The Seattle-Tacoma Power Company is planning to equip its transmission line from Everett to the power plant at Snoqualmie Falls with new insulators for a change of voltage from 15,000 to 60,000 during the coming summer. The cost of the work is estimated at about $20,000. Morton Ramsdell is manager.

RITZVILLE, WASH.—The Washington Water Power Company, of Spokane, has been granted a franchise by the County Commissioners to erect transmission lines along the public highways of the county outside of the incorporated cities and towns to distribute electricity for lamps and motors.

SEATTLE, WASH.—Bids will be received until May 23 for the construction of the power plant for the State University. The cost of the plant is estimated at $80,000. A. H. Markwort is engineer and architect.

SEATTLE, WASH.—The Seattle-Tacoma Power Company has been granted permission to erect a power station on Western Avenue, adjoining the present transformer house of the company. Machinery having a rating of 1500 hp will be installed. Provision will be made to double the output of the plant when needed. N. H. Lattimer is president.

SEATTLE, WASH.—The Seattle, Snohomish & Everett Railway Company, recently incorporated, is planning to build an electric railway from Seattle to Everett, by the way of Bothell and Snohomish. The road from Seattle to Bothell, a distance of 12 miles, will be completed during the coming summer. The company is capitalized at $500,000, and the incorporators are C. W. Kimball, Joseph H. McLaughlin and Clyde C. Chittenden.

SPOKANE, WASH.—Jay P. Graves, president of the Spokane & Inland Empire Electric Railway Company, has applied to the City Council for a franchise to construct an electric railway in Mindenhall Avenue, which will give direct service to the Spokane Interstate Fair Association's Grounds.

WENATCHEE, WASH.—The City Council has granted a franchise to the Entait Power Company to erect and operate an electric plant to furnish electricity for lamps and motors in the city. The company has commenced work on the construction of its plant, the cost of which is estimated at $100,000.

NEW MARTINSVILLE, W. VA.—The plant and holdings of the Wetzel & Tyler Electric Railway Company, including the franchise and railway in Sistersville, have been sold to H. W. McCoy, of Sistersville. E. L. Robinson is special receiver for the road in Martinsville.

BERLIN, WIS.—It is reported that the Oshkosh Traction Company has purchased the Winneconne branch from Rush Lake Junction of the Chicago, Milwaukee & St. Paul Railway Company. The Oshkosh Traction Company, it is said, will equip the road to be operated by electricity in connection with the present interurban railway running between Oshkosh and Omro.

MILWAUKEE, WIS.—The Plankinton Light & Heat Company is making arrangements to make extensions to its plants and to increase the area of its service.

MILWAUKEE, WIS.—An order signed by Judge Grosscup, of Chicago, permitting the sale of receiver's certificates of the Chicago-Milwaukee Electric Railway Company to the amount of $1,000,000 has been filed in the local Federal Court. As soon as a working force can be organized work will commence on the construction of the road in this city.

MONROE, WIS.—The Jefferson Telephone Company is making arrangements to erect new lines in this city and also into the surrounding country.

ROSENDALE, WIS.—Plans are being considered by the Rosendale Telephone Company to extend its lines to Eldorado.

SHEBOYGAN, WIS.—A deal has been closed whereby the Elkhart-Plymouth Interurban line will be completed by the Milwaukee & Fox Valley Railroad Company. The road will be completed by July 1, and the Sheboygan Light, Power & Railway Company has secured a lease of the tracks for 25 years for a service to Elkhart Lake.

BEULAH, WYO.—Plans are being considered by the Black Hills Traction Company, of Deadwood, S. D., for the construction of a new power plant near Beulah, the cost of which is estimated at $250,000.

BEULAH, WYO.—The Redwater Power Company, of Spearfish, S. D., has secured water rights and the right of way on Sand Creek, above Beulah, and proposes to erect a hydro-electric plant with an output of 1200 hp.

THERMOPOLIS, WYO.—The plant and holdings of the Thermopolis Electric Light & Power Company have been purchased by H. J. Thompson, of Billings, Mont., for $30,000. It is said that the new owner contemplates extensive improvements to the system.

CALGARY, ALB., CAN.—P. A. G. Rodrique has applied to the City Council for permission to construct a street railway. He proposes to secure electrical energy for operating the road from the municipal electric light plant.

CALGARY, ALB., CAN.—Bids will be received until May 15 for installing the following machinery in the municipal electric-lighting plant: One 100-hp reciprocating engine; one 750-kw, three-phase, 60-cycle, alternating-current generator; one 30-kw, direct-current, 120-volt, direct connected, steam-driven exciter set; one "Tirrill" automatic voltage regulator; switchboard of two panels; one station watt meter, and one 750-kw turbo-generator set complete. V. Hill, of Calgary, is engineer.

FORT STEELE, B. C., CAN.—It is reported that the Bull River Power & Light Company will erect a power plant on the Bull River, near Fort Steele, and develop 10,000 hp. The power house will be equipped with percussion water wheels operating under a vertical head of 275 ft. George E. Henderson, of Merrillan, Wis., is manager.

NEW WESTMINSTER, B. C., CAN.—It is stated that the Canadian Pacific Railroad Company is arranging to equip its line between here and Westminster Junction, to be operated by electricity, early next year. F. E. Busteed, Vancouver, B. C., is general superintendent.

PORTAGE LA PRAIRIE, MAN., CAN.—The Central Electric Company, of this city, has submitted a proposition to light the city on a 25-year franchise and proposes to supply 25 arc lamps of 2000 cp each at $125 each per annum, or 30 lamps for $120 each. The price of electricity for lamps under this franchise would be 20 cents per kw-hour. John O'Brien is manager for the company.

RUSSELL, MAN., CAN.—The United Telephone Company has been granted a franchise to erect a rural telephone system throughout Silver Creek municipality. The company expects to commence work on its system this summer.

MALLORYTOWN, ONT., CAN.—The Mallorytown Rural Telephone Company has decided to extend its lines to Lynn, Junetown, Caintown and McIntosh Mills.

MERRITTON, ONT., CAN.—K. L. Aitken, of Toronto, consulting engineer, has submitted a report to the Town Council in connection with an electric lighting system for the town. He places the value of the present street lighting system, which includes poles and wires, which might be used as part of a municipal system, at $4,207, and states that an expenditure of $2,500 more would be sufficient to give a 24-hour service with 180 incandescent street lamps. The street lighting contract expires this year, and the Council is considering the installation of a municipal electric light plant.

TORONTO, ONT., CAN.—The City Council has authorized the signing of the agreement with the Hydro-Electric Power Commission to supply electrical power at $18.10 per hp per year. The city's share of the cost of the transmission line from Niagara Falls will be $828,000. Toronto is the first city to take definite action in this matter.

EASTVIEW, SASK., CAN.—The Eastview Telephone Company is contemplating the erection of a number of rural telephone lines. R. E. Allcock is manager.

ESTEVAN, SASK., CAN.—The ratepayers will shortly vote on a by-law to provide $83,000 for improvements and extensions to the electric light and water plants. For further information address Councilor Davies.

BATOPILAS, MEX.—Ira Bowles, of Batopilas, state of Chihuahua, is preparing to install a hydro-electric plant on the San Miguel River near the town of Batopilas.

CHIHUAHUA, MEX.—The Compañia Electrica y de Irrigacion has obtained from the Government of the State of Chihuahua an extension of time of three years in which to establish its hydro-electric power enterprise on the Conchos River. This company has had plans prepared for a plant which will have an output of 30,000 hp. It will be erected about 25 miles from the town of Santa Rosalia, and electricity will be transmitted to the cities of Chihuahua, Parral, Santa Eulalia, Jiminez and other places in the state, where it will be used for mines and industrial enterprises.

GUADALAJARA, MEX.—The Compañia de Tranvias, Luz y Fuerza de Guadalajara, which operates the lighting and street railway systems of the city of Guadalajara, is preparing to enlarge its generating stations at La Junta and Juanacatlan, state of Jalisco, to meet the increasing demand for electrical energy. The system is to be changed from single phase to the three-phase system.

GUANAJUATO, MEX.—Owing to the increasing demand for electrical power for the operation of the machinery of mines, mills and other industries of the states of Guanajuato, Michoacan and Jalisco, the Guanajuato Power & Electric Company has decided to increase the output of its hydro-electric plant to 28,000 hp. It is stated that practically all of this power is already contracted for. When the enlargement now being made is finished the expenditures will have aggregated not less than $8,000,000. The initial hydro-electric plant of the company was erected at Elduro, state of Michoacan, a few years ago and now has an output of 10,000 hp, all of which is being utilized by the mines of the Guanajuato district and industrial concerns and for lamps in the cities of Guanajuato, Zamora and Irapuato. The company is now installing a second hydro-electric plant, located at El Sabino, state of Michoacan, and will generate 6000 hp. It is constructing a loop transmission line to supply electricity for lamps and motors to La Luz and Leon and other smaller towns.

LA JOYA, MEX.—It is stated that the company which was promoted by James D. Schuyler, of Los Angeles, Cal., to install a large hydro-electric plant at La Joya, on the Conchos River, state of Chihuahua, will soon begin construction work. It is estimated that from 15,000 to 20,000 hp can be developed.

MEXICO CITY, MEX.—The Michoacan Power Company has been granted a concession by the Federal Government to install a hydro-electric plant on the Zacapu River, state of Michoacan.

MEXICO CITY, MEX.—The Mexico City Motor Car & Omnibus Company has established a regular service of electric omnibuses and cabs in this city. The omnibus lines reach points not reached by the electric railway lines, and the electric cabs do a general passenger business. L. C. Browne is general manager.

ORIZABA, MEX.—The Compañía de Luz y Fuerza Motriz Electrica de Orizaba is erecting an addition to its plant, situated on the Rio Blanco, near Orizaba, which will increase the output by 750 hp. The company supplies the city of Orizaba with electricity for lamps and motors. The original plant has an output of 2000 hp.

ORIZABA, MEX.—The Compañia Industrial de Orizaba is installing a new power plant on the Rio Blanco River at Orizaba. The electrical apparatus consists of two 750-kw, alternating-current generators; two 70-kw, direct-current, exciter generators, and four 375-kw, oil-cooled transformers for changing the voltage from 440 volts to 10,000 volts for transmission purposes.

TAMPICO, MEX.—The Secretary of Public Works of Mexico has let the contract for the equipment of the Government wharves at the port of Tampico with electric cranes. Electrical energy for operating the cranes will be supplied by the Compañía de Fuerza Electrica de Tampico. It is reported that the Government has in contemplation the providing of similar equipment for the other ports of the country.

TORREON, MEX.—Fedrico Ritter is arranging to install a hydro-electric plant on the Nazas River near Torreon, in the state of Coahuila.

TEMASCALTEPEC, MEX.—The capital stock of the Sultepec Light & Power Company has been increased from $300,000 to $1,000,000. Hagen, Goodrich & Coughlan, 49 Wall Street, New York, N. Y., are attorneys for the company.

New Industrial Companies.

THE FOLEY-GREGORY ENGINE COMPANY, of Chicago, Ill., has been incorporated, with a capital stock of $25,000, by Daniel F. Flannery, William McKinley and S. Longwell.

THE NATIONAL ELECTRIC DEVICE COMPANY, of San Francisco, Cal., has been incorporated with a capital stock of $50,000 by B. L. York, E. P. Norwood and C. M. Boyd.

THE S. HEALEY COMPANY, of New York, N. Y., has been incorporated, with a capital stock of $20,000. The incorporators are Herbert T. Jennings, James W. McCabe and Sumner Healey, of New York, N. Y.

THE GUARANTY ELECTRIC HEATER COMPANY, of Cleveland, Ohio, has been incorporated, with a capital stock of $10,000, by George Ross, Edward J. Cole, W. J. Barr, J. W. Burrell and William E. Patterson.

THE CONSUMERS' GAS & ELECTRIC FIXTURE SUPPLY COMPANY, of Brooklyn, N. Y., has been incorporated, with a capital stock of $10,000, by Samuel Tepfer, Harry Tepfer and George M. Tepfer, all of Brooklyn, N. Y.

THE BANKERS' ENGINEERING COMPANY, of Chicago, Ill., has been incorporated, with a capital stock of $5,000, by M. L. Rodman and Willard G. Searles. The company proposes to do a general building and contracting business.

THE MORAN VAN FOSSEN & TUCKER COMPANY, of Chicago, Ill., has been incorporated, with a capital stock of $20,000, to manufacture gas and electric fixtures. The incorporators are Lavern W. Thompson, J. T. Tyrell and Percival Steele.

THE WILLEX MANUFACTURING COMPANY, of Rome, N. Y., has been incorporated, with a capital stock of $10,000, to manufacture gasoline engines, etc. The incorporators are F. W. Mills, H. M. Browne and E. J. Forhan, of New York, N. Y.

THE RELIABLE GASOLINE ENGINE COMPANY, of Boston, Mass., has been incorporated, with a capital stock of $20,000. The incorporators are George E. Chase, president; August Adolph, clerk, and Edson J. Smith, all of South Boston, Mass.

THE WATSON MOTOR COMPANY, of Lynbrook, N. Y., has been incorporated, with a capital stock of $10,000, and the following-named directors have been elected: Julian N. Walton, Lynbrook, N. Y.; Eldridge N. Smith, of Brooklyn, N. Y., and George F. Hickey, of New York, N. Y.

F. A. BURDETT & COMPANY, of New York, N. Y. (consulting engineers), have filed articles of incorporation, with a capital stock of $100,000. The incorporators are: S. B. Howard, of Millbrook, N. Y.; A. W. Britton, of East Orange, N. J., and J. D. Baker, of New York, N. Y.

THE SEABOARD ENGINEERING & CONSTRUCTION COMPANY, of Asbury Park, N. J., has been incorporated, with a capital stock of $125,000, by W. W. Kurtz, A. J. Flynn and F. F. Haberstick, all of Asbury Park, N. J. The company proposes to do a general electrical and mechanical engineering business.

New Incorporations.

MODESTO, CAL.—The Tuolumne Water & Power Company, capitalized at $1,000,000, has been incorporated by Warren Gregory and H. H. Rolfe, of San Francisco; Geo. Whipple, of Alameda; Winfield Dorn, of Oakland, and J. L. Lamson, of Berkeley.

BARRY, ILL.—The Hot Air Telephone Company has been organized, with a capital stock of $2,500, by Albert W. Triplett, W. D. Gamble and Orland Havrid.

CHICAGO, ILL.—Articles of incorporation have been filed for the Public Telephone & Messenger Company, with a capital stock of $1,000, by F. M. White, George M. Newhart and Philip Strauss.

CHICAGO, ILL.—Articles of incorporation have been filed with the Secretary of State for the Portland Electric Light & Power Company. The company is capitalized at $15,000. The incorporators are: Fred Frost, John R. Rooney and John P. O'Shaughnessey.

HIGHLAND, ILL.—The Grantfork Mutual Telephone Company has been incorporated, with a capital stock of $2,400, by John Schwartz, J. S. Leef, Nicklaus Trautner, A. L. Hitz, Jacob Raeber and others.

PEKIN, ILL.—The Farmers' Mutual Telephone Company has been organized for the purpose of erecting a telephone system in Groveland, Elm Grove, Tremont, Dillon and Hopedale, with exchanges at Morton, Groveland and Tremont. The company will be capitalized at $25,000, and the following-named officers have been elected: John Sommers, president, and Frank J. Wilkins, secretary.

ROBINSON, ILL.—The Terre Haute, Robinson & Illinois Railroad Company has been organized to build an electric railway from the banks of the Wabash River to Mt. Vernon, Ill., about 100 miles in length. Another company will be organized under the laws of Indiana to build the road from the river to Terre Haute, a distance of about 25 miles. The officers of the company are: H. C. Pugh, of Terre Haute, president; S. C. Wilson, vice-president; F. W. Lewis, secretary; Norman Moss, treasurer, and Baxter L. Brown, of St. Louis, Mo., chief engineer. The contract for the construction of 100 miles from the Wabash River to Mt. Vernon has been let for $2,500,000, to be completed in 18 months.

SCOTT MILL, ILL.—Articles of incorporation have been filed for the Scott Mill Telephone Company. The capital stock of the company is placed at $1,500, and the incorporators are E. A. Meyers, E. F. Byrns and W. J. McClelland.

WINCHESTER, ILL.—Articles of incorporation have been filed for the Winchester Electric Company with a capital stock of $10,000 by William Milhous, C. H. Condit and S. Hainsfurther. The company proposes to operate a heat, light and power plant.

BROOKLYN, IND.—The Brooklyn Mutual Telephone Company has filed articles of incorporation. The directors of the company are J. F. Dobson, Louis Hays, W. A. Morgan, J. M. Lang and E. M. Kramer.

DUPONT, IND.—The New Marion & Dupont Telephone Company has been incorporated, with a capital stock of $10,000, by Jacob Deek, B. J. Johnson, W. E. Fall and John Eckston.

BULAH, KY.—The Bulah Telephone Company has been incorporated, with a capital stock of $500, by R. T. Courtney, G. T. Wooley, W. D. Hagdon and others.

FLEMINGSBURG, KY.—Articles of incorporation have been filed for the Fleming Ice & Light Company with a capital stock of $8,000 by J. L. O'Bannan, Charles E. Rodes, J. H. Powers and others.

GOSHEN, KY.—The Goshen Telephone Company has been incorporated, with a capital stock of $400, by S. J. Bell, Liborn Gooch and others.

LOUISVILLE, KY.—The Kentucky Telephone Company, of Powell, has been incorporated, with a capital stock of $12,000, by J. H. Sherley, Laura Sherley, Henry Watson and others, of Mt. Sterling.

CASS CITY, MICH.—The East Line Telephone Company has been organized by the farmers of Evergreen Township. The company has already constructed five miles of telephone lines east of Cass City and contemplates enlarging its system.

MINNEAPOLIS, MINN.—Articles of incorporation have been filed for the Arizona Southern Power Company, I. A. England, of Alexandria, and A. A. Van Dyke, of St. Paul. The company is capitalized at $50,000, and proposes to construct an electric railway and telephone and telegraph lines.

MINNEAPOLIS, MINN.—The Twin Cities & Lake Superior Electric Railway Company has been incorporated by Edward Henry, of Minneapolis, and F. R. Duxbury, of St. Paul. The company is capitalized at $7,000,000.

MOOSE LAKE, MINN.—The Rural Telephone Company has been organized at this place, and contemplates the erection of a telephone line east from Moose Lake. Charles Gunderson is secretary.

RED LAKE, MINN.—Articles of incorporation have been filed for the Clearwater Telephone Company, with a capital stock of $2,500. The officers of the company are: Charles Sall, president; John Lynch, vice-president; James Walker, secretary, and H. J. Enderle, treasurer.

YAZOO CITY, MISS.—The Rapid Transit Company has been organized, with a capital stock of $10,000, by J. W. Bailey, G. A. Pullen and others.

WILLOW SPRINGS, MO.—The Water, Light & Land Company has been chartered, with a capital stock of $25,000, by G. W. Stough, M. T. January, Levi Cook and others.

CROFTON, NEB.—The Farmers' Mutual Telephone Company has been organized for the purpose of building and operating telephone lines in Cedar and Knox Counties. J. O. Mormann is interested in the enterprise.

BROCKET, N. D.—An independent telephone company has been organized in this city, with a capital stock of $1,500, to erect about 20 miles of telephone lines. P. A. Lee has been elected secretary and treasurer.

Company Elections.

CINCINNATI, OHIO.—At the annual meeting of the Tuscarawas County Electric Light & Power Company the present directors and officials were re-elected.

CINCINNATI, OHIO.—At the annual meeting of the Cincinnati Gas & Electric Company the following officers were elected: Charles P. Taft, president; Louis Hauck, vice-president, and Theodore Clauss, secretary.

CONWAY, MASS.—At the annual meeting of the Conway Electric Street Railway Company the following named officers were elected: Moses Williams, of Brookline, president; J. B. Laidley, of Conway, vice-president; H. E. Fisher, of Somerville, treasurer, and J. B. Laidley, clerk.

DOYLESTOWN, PA.—At the annual meeting of the Philadelphia & Easton Railway Company the following named officers were elected: William P. Ayres, of Wilkes-Barre, president; A. Sickler, of Philadelphia, vice-president; W. S. Chambers, of Doylestown, secretary, and J. C. Lugar, of Philadelphia, treasurer.

CLEVELAND, OHIO.—At the annual meeting of the Cleveland, Brooklyn & Elyria Railway Company the following named officers were elected: J. J. Breitinger, president; W. E. Brooks, vice-president; J. Harry Knisely, Jr., secretary, and B. E. Oppman, treasurer. It is stated that work will commence on the construction of the road soon.

Legal.

INJUNCTION NOT SUSTAINED.—The Economic Power & Construction Company, of Geneva, N. Y., has succeeded in having vacated, with costs, the injunction secured by the Geneva-Seneca Electric Company, of Geneva, temporarily restraining the Economic Company from laying pipes in the streets of Geneva. The court was also of the opinion that the consent of the Public Service Commission was not required, under its direct charter from the state.

PLANKINTON TUNNEL PROJECT.—The Plankinton Light & Power Company, of Milwaukee, Wis., has filed a petition asking the right to begin condemnation proceedings against property north of the Davidson theatre and from that point eastward to the Milwaukee River in order that it may improve and further install tunnels to transmit electricity for light and power to downtown business houses. In connection with this petition an injunction signed by Judge Tarrant, restrains Gimbel Brothers from interfering in any way with the wires, tunnels and piping of the company.

RECEIVER FOR OWOSSO & CORUNNA ELECTRIC COMPANY.—Judge Swan of the United States circuit court has appointed Edward E. Mandeville, of Philadelphia, Pa., and Gilbert L. Taylor, of Owosso, as joint receivers of the Owosso & Corunna Electric Company, of Owosso, Mich. The Fidelity Trust Company, of Philadelphia, Pa., has begun suit in the United States district court at Bay City to foreclose the bonds of the company which are held by the Fidelity Trust Com-

pany, default having been made in the payment of the interest on the bonds. The company operates a street car system in Owosso and Corunna and a lighting plant in Owosso.

ELECTRIC LIGHT COMPANY NOT LIABLE FOR INJURIES TO APPRENTICE WHILE ENGAGED IN WORK NOT ASSIGNED TO HIM.—The foreman of a force of men in the employ of an electric light company assigned two designated and experienced men to the duty of attaching a guy wire to a particular telegraph pole. These two men, without being authorized to do so, delegated the duty to an inexperienced apprentice who, in climbing the pole, came in contact with a wire used in raising and lowering the electric lamp attached to the pole, which wire had, owing to faulty construction and improper insulation, become charged with a current of sufficient voltage to cause death. It was held that the company was not liable for the death of the apprentice, thus occurring while he was engaged in work which had not been regularly assigned to him. An apprentice lineman occupies relations of a special charancter in respect to the company which employs him, just as the company occupies a special position touching its rights and obligations to the apprentice. The company recognizes that the apprentice is under its tutelage and entitled to its special protection, and is not justified and warranted in placing him by its orders in places of danger. On the other hand, the apprentice is not at liberty to select for himself the particular work he is to do, nor the time, place and manner of executing it. He can only do this under the orders and direction of the employer. If he does otherwise, he does so on his own responsibility and at his own risk. It is not for him to determine whether work of a particular kind is dangerous or subject to possible risks and to act on his own judgment. While the climbing of poles and the handling of wires may be within the scope of an apprentice lineman's employment, he is not in the discharge of his duties as an employee when he undertakes to do work of that kind which he has not been directed to do. Maitrejean v. New Orleans Ry. & Light Co., Supreme Court of Louisiana, 46 So. Rep. 21.

DUTY TO WARN EMPLOYEES OF DAMAGES INCIDENT TO WORK.—The duty of an electric light company to warn an employee as to abnormal dangers is not violated, where from either the character of the work or other sources, the employee is possessed of all the information which the master could have furnished regarding such perils; and it has recently been held in Massachusetts that an electric light company was not liable for the death of an employee through coming in contact with a tap wire while stringing wires where the wire was clearly visible, and decedent, an experienced workman, had been informed of all the elements of danger attendant on his employment, and was permitted to perform the work in his own way, with an opportunity of unrestricted observation which the dangerous environment demanded. It appeared from the facts that the electric wires of the defendant's system being in a dangerous condition for want of proper insulation, new wires were to be substituted, and a gang of men, including the decedent, who was an experienced lineman, was sent out to perform the work, under the direction of a general foreman of the company. On changing his position from one crossarm to the next one above, he was obliged to step over the tap wire, which had become charged with an alternating current, the end of which penetrated his body and caused him to fall across other wires which were uninsulated and heavily charged. On these facts the conclusion was reached that, if generally the employer, or one who stands in his place, owes a duty to an employee to warn or instruct him as to abnormal dangers, this duty is not violated, where from either the character of the work, or other sources, the employee is possessed of all the information which the employer could have furnished regarding such perils. Pembroke v. Cambridge Electric Light Company, Supreme Judicial Court of Massachusetts, 84 N. E. Rep. 231.

Obituary.

MR. FREDERIC H. MAY, formerly vice-president and general manager of the American Rapid Telegraph Company, died May 10 at his home in Newark, N. J. He was prominent in railroad building in the West and Middle West in the 70's and won fame during the Civil War by keeping the Illinois Central open for troop and supply trains for General Grant. Mr. May was born on the Isle of Man.

MR. JOHN A. ERNER, president of the Erner Electric Company, of Cleveland, Ohio, died at his home in that city May 7 from the results of an attack of the grip. Mr. Erner was 43 years of age and was formerly with the Bissell, Dodge & Erner Company, of Toledo, and a stockholder of the Erner-Hopkins Company, of Columbus, Ohio. He was a member of the Chamber of Commerce, the Builders' Exchange, the Cleveland Athletic Club, the Catholic Federation and the Knights of Columbus.

Personal.

MR. ALEXANDER SIEMENS has been elected a vice-president of the Institutions of Civil Engineers of England.

MR. NIKOLA TESLA and his new nitrates company have taken offices in the new City Investing Company's building, at Broadway and Cortlandt Street, New York City.

DR. LOUIS BELL has sailed this week for Europe in the interest of several American central stations, to look over the field and make a study of recent developments there.

MR. C. L. KINGSLEY has become a director in the New York Telephone Company in place of Mr. C. Steele, of J. P. Morgan & Co.

THOMAS & NEALL, consulting electrical engineers, have moved their New York offices from 52 William Street to the United States Express Building, 2 Rector Street.

MR. J. S. MONTGOMERY, who has been traveling in the Southern States for the Western Electric Company, is now in the employ of the Federal Electric Company, of Chicago, and has Ohio, Illinois and Indiana as territory.

MR. WILLIAM PLATTNER, superintendent of the municipal electric light plant at Bluffton, Ohio, has been appointed superintendent of the municipal electric light plant at North Attleboro, Mass., to succeed Mr. W. P. Whittemore, recently resigned.

MR. W. BARCLAY PARSONS, of New York City, has been awarded a Telford gold medal by the Institution of Civil Engineers of England in recognition of the merit of his paper read and discussed before that body on underground electric railway development in New York.

MR. PERCY R. FROST, formerly president of the Union Electric Company, of Pittsburg, has accepted the position of sales manager for the large electrical supply house of Stuart-Howland Company, of Boston. The company is to be congratulated on securing a competent official, Mr. Frost standing high in the estimation of the electrical industry.

MR. WILLIAM E. PRICE, who has had charge of the electrical department of the Pueblo & Suburban Traction & Lighting Company, of Pueblo, Col., will hereafter act as consulting engineer of the company with headquarters at Pueblo. Mr. T. C. Roberts, master mechanic of the Pueblo plant of the American Smelting & Refining Company, has been appointed superintendent of power and shops for the Pueblo & Suburban Traction & Lighting Company, with headquarters at Pueblo.

MR. J. T. CORNISH, chief engineer of the La Capital Traction & Electric Company, Metropolitana Tramway, Grand National Tramway Company, Buenos Aires Electric Tramway Company, Belga Argentina Tramway Company, and consulting engineer of the Cordoba Light & Power Company, has been appointed resident engineer of the City of Santos Improvements Company, of Santos, Brazil, controlling the gas, water, electric lighting and tramways in that city. Mr. Cornish left Buenos Aires May 1 to take up his duties at Santos.

MR. HENRY FLOY.—According to the Syracuse, N. Y., newspapers, Mr. Henry Floy, the well-known electrical engineer, has been approached on the subject of succeeding Dean Kent at Syracuse University. Mr. Floy has declined to say anything on the subject, but there is no doubt as to the authenticity of the report. Mr. Floy is a graduate of Wesleyan and Cornell Universities and has been engaged in practice for some years past as a hydraulic and electrical engineer, with a consulting practice all over the country. He is a member of the American Institute of Electrical Engineers, the Illuminating Engineering Society and other bodies.

MR. H. L. WELLS, formerly advertising writer for the Allis-Chalmers Company, Milwaukee, more recently publicity manager of the Power & Mining Machinery Company, Milwaukee, has opened an office in Chicago at No. 1205 Monadnock Block, for the general practice of technical or trade journal advertising, and is now ready to undertake work of any kind in the broad field of publicity for manufacturers of machinery and allied products, the regular service to be rendered on a monthly or yearly salary basis. Mr. Wells' long experience in the preparation of attractive copy and complete catalogs for firms of world-wide reputation fits him eminently for serving his clients in this broader field of work.

DR. SCHUYLER SKAATS WHEELER, past president of the American Institute of Electrical Engineers and president of Crocker-Wheeler Company, recently addressed the Engineering Society of Columbia University on the subject of "Engineering Honor." As an undergraduate at Columbia, in the class of '83, he, with Prof. F. B. Crocker, had addressed the same society on technical subjects. After declaring that he felt the audience before him to be more sympathetic than any of the audiences he had addressed on engineering ethics, he alluded to the ethical codes of the various so-called learned professions. He spoke also of the code which he proposed in his presidential address before the American Institute of Electrical Engineers. Dr. Wheeler mentioned three great duties of the engineer in the order of their importance—first, the engineer's duty to his client; second, to the public, and, third, to his engineering society. He condemned strongly the publication of false scientific and false engineering statements in the newspapers, and insisted that discoveries and inventions should be announced not in the daily papers, but through the technical societies or the technical press.

Removals.

THE AMERICAN STEEL FOUNDRIES have changed their New York office from 42 Broadway to the Hudson Terminal Building.

FORT WAYNE ELECTRIC WORKS.—The New York office of the Fort Wayne Electric Works, formerly located at 40 New Street, has been moved to the Cortlandt Building, Hudson Terminal, 30 Church Street. The new office is on the 15th floor.

AMERICAN BRIDGE COMPANY.—The Boston offices of the American Bridge Company have been moved to the Oliver Building, 141 Milk Street. The American Bridge Company has moved its office to the Hudson Terminal Building, Church Street, New York City. Watson-Stillman Company has moved to the same building.

Trade Publications.

OIL-BREAK SWITCHES.—The General Electric Company, Schenectady, N. Y., in bulletin No. 4576, describes the Type F, Form K-3 line of 4500-volt oil switches for panel installation and remote control. This switch has been especially designed with a view to combining satisfactory operation with low price and is claimed to meet the most severe requirements of service on systems at e.m.fs. of 4500 volts or less.

CENTRAL DISCOUNT SHEET.—The Central Electric Company, of Chicago, has issued a new trade discount and price list, applying to its 1906-1907 general catalogue. This price-list has been revised. It cancels all previous quotations, and now contains the most up-to-date prices of electrical appliances sold by them. It is dated May, 1908, and is now being distributed. Holders of catalogs who do not receive a copy of this price-list should write for one.

MOTOR-DRIVEN VACUUM CLEANER.—The Electric Renovator Mfg. Co., Farmers' Bank Bldg., Pittsburg, Pa., has issued an extremely attractive catalog, dealing with its motor-driven centrifugal air pump for vacuum cleaning processes. The apparatus is entirely self-contained and is quite compact. The catalog contains a large list of users of "Invincible" cleaners, which includes many public buildings, churches, theatres, hotels, stores, residences and house-cleaning firms.

ADVERTISING.—"What Makes the Best Advertising Medium" is the name of a neat, well-printed pamphlet consisting of a series of articles reprinted from *Selling Magazine,* written by Mr. Emerson P. Harris. The question is discussed in this pamphlet in a clear, concise and unbiased manner. The articles are full of interesting reading which will be of great value to every man who is called upon to decide the question of what advertising medium he will use to promote the welfare of his business. The price of the book is 50 cents, but it will be sent free to any reader of Electrical World who will write for it to *Selling Magazine,* Postal Telegraph Building, New York.

"TRUMBULL CHEER," issued by the Trumbull Electric Manufacturing Company for May, is an anniversary number. It gives a most interesting story of the growth of the business in seven years, from the occupancy of a little old chuck factory to the present handsome buildings at Plainville, Conn. At first and for some time knife switches were made, but successive new lines were taken up, and last August the panel and switchboard factory was erected. Views are given of the factory, with work in progress, and a lot of chatty data and points are given as to features of the industry. At first as now the company consisted of Frank T. Wheeler, president; John H. Trumbull, treasurer, and Henry Trumbull, secretary. There has been no change of personnel or position.

ENGINEERING INDEX ANNUAL.—The *Engineering Magazine,* 140 Nassau Street, New York, has just issued its "Engineering Index Annual" for 1907. In this volume, as in that for 1906, issued about a year ago, the classified system has been adhered to, which is followed in the monthly parts. The reason given is that it makes the maintenance of the publication commercially practicable. The five-year volume was a burden of expense, "which even great devotion to the profession could not bear with any equanimity." Apart from that, the annual form has the advantage, both to consultants and to publishers, that it indexes current literature while it is still fresh, timely in point of practice and more readily obtainable. The publishers have improved the arrangement of the items, clarified the classification, standardized catch words and brought all references to a subject together with abundant correspondences.

Unclassified Items.

HINCKLEY, MINN.—A franchise has been granted to J. J. Coburn, of Cloquet, to construct an electric light plant in this town. It is expected that the water power of Grindstone will be utilized to generate electricity.

EDGELEY, N. D.—The Aberdeen Electric Company has been awarded the contract for the construction of the pole line for the municipal electric light plant, and Fairbanks, Morse & Company was awarded the contract for the dynamo, engine and other equipment.

COQUILLE, ORE.—The Coos County Electric Light & Power Company has been organized by W. C. Rose, George A. Robinson, C. R. Barrows, E. C. Barker and C. C. Evland. The company has filed water rights on the North Fork River from the mouth of Big Creek to the Fox Bridge at Fairview. It is estimated that 6000 horse-power can be developed. The company will furnish electricity to Coquille and other towns in Coos County.

LEHIGH, IOWA.—Plans are being considered by H. V. and J. M. Williams for the installation of an electric light plant.

GENEVA, N. Y.—Plans are being prepared by the Geneva-Seneca Electric Company for the construction of a new power plant to cost about $150,000. The equipment of the plant will include four 500-kw, three-phase, 60-cycle generators direct connected to turbine engines.

CASHTON, WIS.—Plans are being considered for the construction of an electric light and water works station, the cost of which is estimated at $15,000.

CARLETON, MICH.—The Washtenaw Light & Power Company has been granted a franchise by the Huron Township to erect its transmission lines through the town. The company proposes to furnish electricity for lighting between Geddes and Trenton, and will supply several of the towns through which its line extend with electricity for the same purpose.

FARIBAULT, MINN.—The City Council has passed upon the first reading of an ordinance granting a franchise to the Minneapolis, St. Paul & Dubuque Electric Traction Company to enter the city. The company will be required to build an extension from here to Shieldsville, passing Roberts, French and Shieldsville Lakes.

POPLARVILLE, MISS.—The Board of Mayor and Aldermen has adopted a resolution ordering an issue of $10,000 in bonds, the proceeds to be used for paying a balance due on the electric light plant and water works system and also to improve and extend the service.

ELLSWORTH, MINN.—The Village Council has granted F. M. Sadler a 25-year franchise to furnish electricity for lighting the town. The franchise carries with it a provision that the city can purchase the plant at the end of any period of five years.

MARQUETTE, MICH.—Plans and specifications have been authorized by the Board of Light and Water Commissioners for the construction of a new substation in connection with the present electric system.

BRISTOL, R. I.—Extensive additions are contemplated for the power plant of the National India Rubber Company, which includes the installation of a 1000-hp engine and three additional engines aggregating about 1000 hp, manufactured by the Hewes & Phillips Iron Works, of Newark, N. J., together with three Crocker-Wheeler generators to furnish electricity for lamps and for motors.

DETROIT, MICH.—The Stecker Electric & Machine Company is making arrangements to erect a new factory building near Woodbridge and Bates Streets, which will be equipped with motor drive throughout.

WASHINGTON, D. C.—Bids will be received until May 26 at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., to furnish at the navy yards and naval stations the following supplies: Puget Sound, Wash., Schedule 1130—15,000 ft. galvanized iron wire; 300 dry batteries; 300 lb. micanite plate. Schedule 1133—12,000 lb. ingot copper. Schedule 1151—electrical supplies; connecting boxes; electric fixtures; 8000 attachment plugs; water tight communicators; transmitters and indicators. Schedule 1153—hard brass wire; galvanized steel wire. Mare Island, Cal., Schedule 1132—6700 lb. sheet; 3800 lb. galvanized hook steel; rolled bronze; phosphor bronze. Schedule 1153—steel plates. San Francisco, Cal., Schedule 1131—about 4500 ft. rubber-covered copper wire; 700 ft. copper stranded dynamo flexible cable. Applications for proposals should designate the schedules desired by number. F. B. Rogers, paymaster-general, U. S. N.

SPRINGFIELD, MASS.—The Enfield Power Company has been organized for the purpose of building a power plant on the Connecticut River at Warehouse Point and in aiding the United States Government in opening the Connecticut River to navigation between this city and Hartford. In return for permission from the Government to use the water power to generate electricity, the company will dredge a canal from Windsor Locks to Hartford, which can be used for all boats passing up and down the river. The officers of the company are: Charles H. Tenney, of Springfield, president; Ralph P. Allen, vice-president, and Ambrose Clogher, of Pittsfield, Mass., clerk.

CLARKSDALE, MISS.—Walter G. Kirkpatrick, of Jackson, consulting engineer, has been engaged by the city to take charge of the installation of a direct connected unit in the municipal electric light plant, and extension of water mains, sewers, and other improvements, the cost of which will aggregate about $55,000.

OKLAHOMA CITY, OKLA.—The Somerville Light & Ice Company has been incorporated with a capital stock of $25,000 by J. D. Giddings, R. E. B. Bledsoe, of Somerville, Tex., and others.

SUMPTER, ORE.—The Columbia Mine is making extensive improvements in its plant and is making arrangements to operate its machinery by electricity.

Business Notes.

THE NUTTING-ROE ELECTRIC COMPANY, of Muncie, Ind., recently incorporated, will establish and equip a plant to manufacture and sell electrical equipment of all kinds. K. E. Nutting and M. L. Roe, directors

CENTRAL ELECTRIC COMPANY AT THE N. E. L. A.—The Central Electric Company is planning to have a large exhibit of high tension insulators, and other specialties of this nature. The exhibit will be shown in booths 23, 24, 47 and 48.

THE BASELER, LAWRENCE & HEINEKEN COMPANY, of Philadelphia, Pa., is planning to establish a plant in Havre de Grace, Md., for manufacturing electrical switchboards, fixtures and supplies. William H. Brown, Isaac Hecht and P. L. Hopper have been appointed to take charge of the project.

"POPULAR ELECTRICITY" is the name of a new magazine published in Chicago by the Popular Electricity Publishing Co., of which Mr. Samuel Insull is president and Mr. E. B. Overshiner, vice-president, with offices at 1116 Fisher Building. The new magazine, although devoted exclusively to the subject of electricity, is of a non-technical nature and will appeal to the general reader. It is aimed to meet the wants of the average person who desires to become conversant with electrical things in general but who finds the specialized technical journal too deep. "Popular Electricity" is written in "Plain English," is interesting and should

go a long way toward creating a desire on the part of its readers to avail themselves of the advantages which may be derived in a thousand and one ways by the use of electricity. As such, it should enjoy the approval and co-operation of the entire electrical fraternity.

THE CROCKER-WHEELER COMPANY will exhibit at the N. E. L. A. convention a lighting transformer, small induction motor and a Form L direct-current motor. Heretofore the company has made its chief offering to central stations in the line of direct-current generators, alternating-current generators and its Form L direct-current motors. It now takes its place as a supplier of alternating-current and direct-current motors and transformers of the high C-W standard.

H. W. JOHNS-MANVILLE COMPANY IN DETROIT.—The business interests of the H. W. Johns-Manville Company in Detroit and the territory adjacent thereto have increased to such an extent that a new branch is about to be opened by that company. This branch will be located at 72 Jefferson Avenue, Detroit, under the management of Mr. Willard K. Bush, who is well known throughout that section of the country, having been connected with the Milwaukee branch of the company for a number of years. The company will carry a complete stock of goods at the Detroit branch, so that shipments can ordinarily be made direct from local stock.

WHEELER CONDENSERS.—Mr. D. D. Pendleton has been appointed the Pittsburg representative of the Wheeler Condenser & Engineering Company, of Carteret, N. J., and will hereafter handle the sale of Wheeler surface, jet and barometric condensers, Wheeler-Volz combined condenser and feed heater, Wheeler-Barnard water cooling towers, Edwards wet vacuum pumps, and other Wheeler specialties, such as dry vacuum pumps, centrifugal pumps, vertical engines, vacuum pans, multiple effect distilling apparatus, etc., in that territory. Mr. Pendleton has, during the past 15 years, occupied various positions in the manufacturing, engineering and sales departments of the Westinghouse Companies and is well acquainted with the industries of Western Pennsylvania, particularly with the designing and installation of mine power plants. His offices will be located in the Frick Annex.

REYNOLDS FLASHERS.—An important announcement to the trade with regard to some recent litigation and its effect has been made by the Reynolds Electric Flasher Manufacturing Company, of Chicago, from which we abstract the following: "On April 22 a judgment was rendered in the Circuit Court of this city restraining us from the further manufacture of the Reco and Improved Reynolds Flashers. This decision was reached in consideration of the fact that our type of flashers had embodied certain parts protected by a patent granted in 1896. Although we have always felt that our devices were no infringements, but the result of many years of careful and costly experimenting, we are neither surprised nor handicapped at this decision of the court. On the contrary, we have well provided ourselves for this event, and we have a flashing device that is superior to our previous flashers, and to those of any competitor. This flasher we have named the New Reco. The New Reco is now on the market, and cuts and explanations of its superior features will be mailed as soon as the photo-lithographer and printer have done their work. In the decision of Judge Kohlsaat, of the United States Circuit Court, he gives us full credit of reinventing the Sinclair device, without having seen or heard of the Sinclair patent. He also gives us our due credit for having made the electric flasher a commercial machine, and for resurrecting the patent from its burial in the tomes of the Patent Office. There is, therefore, not the slightest reason for our friends to be alarmed. Nothing has been changed in the course of our business, and we shall continue to make every effort to justify the confidence our friends have always been kind enough to place in us."

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED MAY 5, 1908.

[Conducted by Rosenbaum & Stockbridge, Pat. Attys., 41 Park Row, N. Y.]

886,338. PRINTING TELEGRAPH; John C. Barclay, New York, N. Y. App. filed Aug. 15, 1905. Printing telegraph system of the stock-ticker type, having means for operating a two-wire ticker or printer circuit from a distant transmitter by means of a single line circuit. Has repeating means whereby signals may be repeated into a further line circuit for operating tickers or printers.

886,339. AUTOMATIC TELEGRAPH TRANSMITTER; John C. Barclay, New York, N. Y. App. filed July 22, 1907. Automatic telegraph transmitters of the type in which the transmitting mechanism is controlled by a suitably marked or perforated message strip. Provides means whereby it is impossible to throw the hand transmitter into circuit without simultaneously stopping the feed of the message tape.

886,355. INVISIBLE ELECTRIC BURGLAR AND FIRE ALARM; James W. Dawson, Kansas City, Mo. App. filed Sept. 12, 1907. Relates to electric alarms and more particularly to invisible burglar and fire alarm systems, which will be operated through the opening of the door or by a person walking against a thread stretched in such a position that it cannot be avoided.

886,371. SYSTEM OF ELECTRICAL DISTRIBUTION; Albert S. Hubbard, Belleville, N. J. App. filed Aug. 10, 1905. Relates to systems of electrical distribution in which an auxiliary storage battery is connected in parallel to a compound wound main generator in order that the battery may maintain a substantially constant load on the main generator.

886,372. ELECTRICAL SYSTEM OF DISTRIBUTION; Albert S. Hubbard, Greenwich, Conn. App. filed Apr. 15, 1905. Provides an arrangement of regulating apparatus which will act to maintain the load on the main generator much more constant than it has hitherto been possible to maintain it; varies the primary regulation by means of fluctuations in the generator branch of the circuit.

886,374. HEAT-COIL AND PROTECTOR UNIT; William Kaisling, Chicago, Ill. App. filed May 29, 1905. In a protector unit, a mounting base having a bifurcated end adapted to be clamped by a bolt or screw, and protective devices mounted upon said mounting base adapted to furnish complete equipment of heat coil and carbon arrester protection for one telephone line independently of other similar units.

886,395. SYSTEM OF ELECTRICAL REGULATION; Morris Moskowitz, New York, N. Y. App. filed June 28, 1907. Provides means to vary the output of a generator in accordance with the load on the work circuit. Includes a carbon resistance having a variable pressure device actuated by a differentially wound solenoid.

886,443. VIBRATOR; Egmont Max Tormin, Newton, Mass. App. filed Jan. 23, 1908. A form of vibrator for an induction coil designed to avoid sparking at the terminals. Has high resistance coils in series with the primary windings and having a condenser in parallel therewith, the circuit being continually closed. The vibration is closed by short circuiting the magnetic coils by the action of the vibrator.

886,445. CAR LIGHTING SYSTEM; William A. Turbayne, Lancaster, N. Y. App. filed June 20, 1906. Car lighting system in which a main dynamo is provided and driven in a suitable manner from the car, while a storage battery is connected across its terminals. Employs a "crusher" between the battery and the lamp circuit, and regulated by a variable speed apparatus.

886,475. CUT-OUT BLOCK; Fred Brunberg, Windber, Pa. App. filed Apr. 25, 1907. A trolley switch having a depending arm which is moved to and fro by the engagement of the usual trolley wheel. Is particularly for use in mine tunnels where electric cars are used for the purpose of transporting material into and from the mine.

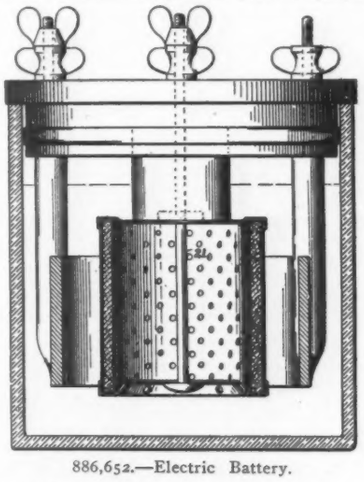
886,498. SYSTEM FOR MEASURED TELEPHONE SERVICE; James Harrison, St. Louis, Mo. App. filed May 10, 1905. Details of cord circuits for party line system.

886,517. TROLLEY HARP; Hugh W. Kimes, Dayton, Ohio. App. filed Jan. 13, 1908. A form of trolley harp having an axle clamped rigidly in the harp to insure good electrical contact. Makes use of a pin passing through the axle and which is received in a clamping device to prevent displacement.

886,559. BRUSH HOLDER; William L. Waters, Milwaukee, Wis. App. filed June 3, 1905. A brush rocker is pivoted to the holder by a swinging connection spring-impelled toward the commutator by an adjustable spiral spring received between the bifurcated arms of the rocker.

886,561. COIL SUPPORT; William L. Waters, Milwaukee, Wis. App. filed Sept. 4, 1906. A means for supporting the armature coils of dynamo-electric machines. Provides a coil support in the form of a bracket which is clamped at one end to the machine frame and is provided at its other end with an engaging surface to which the coils may be secured by means of rope or similar material passing about the coils and through an opening in the support proximate to the engaging surface.

886,562. DYNAMO-ELECTRIC MACHINE; William L. Waters, Milwaukee, Wis. App. filed Dec. 13, 1906. Brush holder mechanism for dynamo electric machines designed to prevent sparking between the commutator and the machine frame. In street railway work there is a tendency for the commutator to flash over to the frame of the machine at the time of quick voltage changes. The patentee provides an insulating shield to intercept this discharge.



886,652.—Electric Battery.

886,566. ELECTRIC CABLE; Charles E. Wilson, Philadelphia, Pa. App. filed July 13, 1905. An electric cable having a plurality of wires composed of successive lengths of electrically conductive materials differing in their magnetic permeability. Is intended to answer the purposes of the present telephone lines having loading coils.

886,620. ELECTRIC SIGNALING APPARATUS FOR RAILROADS; Paul Julius Matter, Coswig, Germany. App. filed Dec. 19, 1907. Relates to improvements in electric signaling apparatus for railroads designed to provide an alarm indication within the engine cab in case two trains run on the same block section. Makes use of a trolley conductor the circuit of which extends through signal lamps along the roadway and which receives its power from a generator on the wheel axle of the train.

886,624. AUTOMATIC FIRE ALARM; William Tom Munro, East Blairlinn, Cumberland, Scotland. App. filed Jan. 28, 1907. Has two vessels filled with gas, one at a higher pressure than the other. One of the

vessels is more easily affected by heat than the other, whereby a gradual change of temperature has no effect, but a sudden change of temperature causes an alarm circuit to be closed.

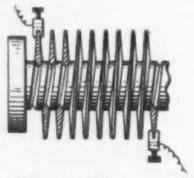
886,634. CABLE HANGER; Henry W. Pleister, Newark, N. J. App. filed Jan. 24, 1907. A wire frame having hooked extremities for the purpose of suspending a cable from a messenger wire. Makes use of a strap of fabric material to directly engage the cable.

886,645. TROLLEY GUARD; Jean E. Saucier, Montreal, Quebec, Canada. App. filed June 30, 1906. In addition to the usual trolley wheel, the patentee has a barrel-shaped roller on a frame pivoted to the harp and extending rearwardly therefrom. The purpose is to make a double contact with the wire and prevent flashing.

886,649. BATTERY COVER AND ELEMENT SUPPORT; Charles B. Schoenmehl, Waterbury, Conn. App. filed May 29, 1905. A battery cover having an integral extension to enclose the supporting rod and the end of a battery element, and a shouldered pocket in said extension to hold the element and rod from turning.

886,650. BATTERY COVER AND ELEMENT SUPPORT; Charles B. Schoenmehl, Waterbury, Conn. App. filed May 29, 1905. Relates to modifications of the above.

886,651. NEGATIVE ELEMENT FOR PRIMARY BATTERIES; Charles B. Schoenmehl, Waterbury, Conn. App. filed June 2, 1905. A battery element comprising a mass of black oxide of copper having its surface metalized and oxidized and coated with finely divided particles of metallic copper.



886,682.—Electric Heater and Rheostat.

886,652. ELECTRIC BATTERY; Charles B. Schoenmehl, Waterbury, Conn. App. filed March 29, 1906. A negative element for batteries comprising a thin pressed cylinder of metal oxide, having a perforated sheet of metal upon the outer side and a bolt-supported perforated flanged sheet of metal upon the under side.

886,676. AUTOMATIC ELECTRIC SIGNAL SYSTEM FOR RAILWAYS; John P. Buchanan, Cleveland, Ohio. App. filed Aug. 3, 1906. Has means for controlling or elminating the "sneak" currents by means of relays which are energized to establish discharge circuits.

886,678. ELECTRIC DRIVEN TOOL; Allen F. Carver, New York, N. Y. App. filed Feb. 5, 1907. A means for preventing the magnetization of the hard metal parts which has hitherto given rise to inefficiency in electric hammers on account of the magnetic action set up by their relative movement.

886,682. ELECTRIC HEATER AND RHEOSTAT; James H. Delany, Berwyn, Ill. App. filed Aug. 23, 1906. The patentee has a specially rolled bar for his resistance element, which takes the form of a helix by virtue of the rolling process.

886,706. VAPOR ELECTRIC LAMP; Richard Kuch, Hanau, Germany. App. filed Sept. 6, 1905. A gas or vapor electric lamp having the electrode material formed of a mixture of metals vaporizable at different temperatures, the metal constituting the greater part of said mixture being vaporizable at a higher temperature than the remainder of the mixture.

886,733. CONTROLLER; George B. Schley, Norwood, Ohio. App. filed Dec. 31, 1906. A controller device for electric motors designed to be fool proof in all particulars, among them to prevent the controller being moved backward from a running to a starting position.

886,740. RELAY FOR SIGNALING APPARATUS; Louis H. Thullen, Edgewood Park, Pa. App. filed March 25, 1907. An alternating-current relay for use in signaling systems where an alternating current of one frequency is used for propulsion purposes, and an alternating current of a different frequency is used in the track or signaling circuit.

886,755. TELEGRAPH INSTRUMENT; Benjamin F. Bellows and Ambrose Behner, Cleveland, Ohio. App. filed Sept. 27, 1904. Has a key by which one movement will make dashes and another movement will release automatic mechanism to make dots until the return of the key to normal position cuts off the dots. Makes use of vibrating pendulums having a different periodicity of movement.

886,757. ART OF REDUCING ALUMINUM AND OTHER METALS; Henry Spencer Blackmore, Mount Vernon, N. Y. App. filed Nov. 14, 1905. The process of reducing metal from substances containing the same, which consists in liberating the metal by the combined action of metal-yielding and non-metal-yielding electric currents, disposed through the metal-containing substances in a parallel path.

886,774. WIRE TIE; Harry A. Drew, New York, N. Y. App. filed April 18, 1907. A fastener for engaging a conductor to a porcelain insulator, making use of a stiff curved wire hook which embraces the insulator and resiliently engages the conductor.

886,811. ELECTRICAL CONNECTION; George H. Jacob and John L. Hagadorn, Detroit, Mich. App. filed July 14, 1906. A flush plug for providing electrical connection with a fixed socket and constructed to carry the conductors of the extension and insure proper electrical contact of said conductors with the conductors of the socket to form a continuous circuit by the introduction of the plug into the socket.

886,821. ELECTRIC INCANDESCENT LAMP; Hans Kuzel, Baden, near Vienna, Austria-Hungary. App. filed July 16, 1907. In an electric incandescent lamp, the combination horseshoe shaped metal filament having the free ends of its legs fastened to leading-in wires, and a plurality of holding devices within the bulb of the lamp adapted to loosely guide each of said legs longitudinally at a plurality of points, the line connecting the centers of successive holding devices of each leg being a helical line.

886,824. CHOKE-COIL; Louis O. Langworthy, Bradford, Pa. App. filed Oct. 4, 1907. A choke-coil comprising two cores with coils wound thereabout and means for holding the same in a predetermined direction, and adjusting one core and coil to the other core and coil to produce a variable air gap.

886,827. ELECTRIC DOOR OPENER; Joseph Lock, Brooklyn, N. Y. App. filed April 16, 1907. A door lock mechanism designed to operate with a minimum amount of force on the operating magnet, regardless of how much pressure may tend to bind the lock of the door. Makes use of a compound tripping movement.

886,847. AUTOMATIC RAILWAY SIGNAL; James P. Norwood, Chicago, Ill. App. filed Oct. 5, 1906. A signal system adapted for use at a railroad crossing, designed to display signals and make a time indication as to the position of the trains in approaching or receding from the crossing.

886,856. ELECTRIC FURNACE; Edgar F. Price, Niagara Falls, N. Y. App. filed Nov. 14, 1905. Construction of electric furnace having an open bottom beneath which is a movable receptacle which receives the molten product and is shifted to withdraw its contents from the product remaining in the furnace.

886,857. ELECTROLYTIC PROCESS OF PRODUCING METALS; Edgar F. Price and William Smith Horry, Niagara Falls, N. Y. App. filed Dec. 29, 1906. The process of producing calcium, which consists in electrolyzing a molten compound of calcium with an anode comprising calcium carbid.

886,858. PROCESS OF PRODUCING LOW-CARBON FERRO-ALLOYS; Edgar F. Price, Niagara Falls, N. Y. App. filed Sept. 24, 1907. A process comprising two stages in which the ore is first reduced in an electric furnace by an excess of carbon and the carbon thereafter removed by electrically heating the molten alloy to a temperature such that the carbon is burned off.

886,869. ELECTROMAGNET; Harold Rowntree, Chicago, Ill. App. filed June 23, 1905. A magnet in which the pull exerted on the core will not be weakened by induced currents and in which quietness of action without the generation of heat is insured. Has a plunger composed of laminations united solidly together at one end and disconnected at all other points.

886,870. ELECTROMAGNET; Harold Rowntree, Chicago, Ill. App. filed April 6, 1907. Relates to modifications of the above.

886,874. APPARATUS FOR PRODUCING ELECTRIC DISCHARGES THROUGH GASES; August Schneller, Ginneken, near Breda, Netherlands. App. filed April 25, 1904. An apparatus for subjecting gases to invisible electric discharges, comprising discharge terminals and means for circulating therebetween a flowing medium for the purpose of cooling said terminals.

886,879. SIGNALING SYSTEM; John Shepherd, Chicago, Ill. App. filed Sept. 17, 1906. A combined fire-alarm and watch-service signal system. Provides a transmitter adapted for use as a combined watch box and fire-alarm box, whereby the watch signal is characteristically different from the fire signal.

886,880. TROLLEY; John Shepherd, Chicago, Ill. App. filed Dec. 20, 1907. An anti-friction bearing for a trolley wheel designed to permit movement of the axle whereby the latter may partake of movements to maintain the wheel in properly contacting relation with the wire at all times.

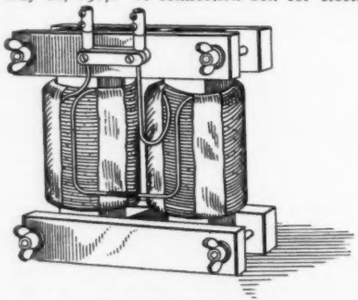
886,833. COMBINED GAGE AND SIGNAL DEVICE; Mark G. Melvin, Scranton, Pa. App. filed March 16, 1907. Gage for indicating the pressure of steam or water, or the height of water in a tank. Has an audible electric signal connected in circuit at either high or low predetermined limits of pressure or height of water.

886,909. PARTY-LINE TELEPHONE SELECTOR AND LOCK-OUT; Herbert D. Williams, Vermillion, Kan. App. filed June 19, 1906. In a telephone system the combination with a central office and a plurality of subscribers' stations comprising local signal and talking circuits, a switch for controlling each talking circuit, means for locking said switch in inoperative position, means for impressing currents of different intensities upon the line, means responsive to current of certain intensity for releasing the locking means, and means controlling said responsive means and the signal circuit.

886,942. TROLLEY LINE CLAMP; Auguste Caron, Indian Orchard, Mass. App. filed July 25, 1906. A trolley line clamp in which the trolley conductor is bent on a fixed radius of curvature and engaged between the members of a clamp, which has a lower surface adapted to guide the trolley wheel at the portion where its continuity is interrupted by said bend.

886,947. RAILWAY BLOCK SIGNAL; David H. Cocker, Piedmont, and Whitfield A. Scarbrough, Choccolocco, Ala. App. filed April 3, 1907. Mechanical construction of semaphore device and circuit-closing apparatus therefor, making use of tappets which are displaced by the wheel flanges of a passing train and which close circuits to energize electric magnets for the semaphores.

886,978. CONNECTION BOX; Russel Dorr Holabird, Los Angeles, Cal. App. filed May 21, 1907. A connection box for electric wiring, comprising a body section and interchangeable end sections, said sections having co-operating connecting means and additional means for connecting a plurality of body sections to form a larger sectional box.



886,824.—Choke Coil.

886,983. COHERER AND DECOHERER; Joseph L. Jones, Kizer, Tenn. App. filed Dec. 26, 1906. A form of vibrator for a coherer making use of a magnet having a depending armature which carries the coherer so that the latter is vibrated back and forth.

886,993. ELECTRIC SIGNAL FOR RAILWAYS; Anton Kuzel, Cleveland, Ohio. App. filed Dec. 30, 1907. The track is equipped with special mechanical tappets at the locations to be protected, and these engage devices on the locomotive, so as to establish alarm signals in the engine cabs in case two locomotives are simultaneously located on the protected track section.

887,038. DUPLEX TELEGRAPH; John L. Ghegan, Newark, N. Y. App. filed May 20, 1907. A duplex telegraph system having differential or double wound relays and designed to have one or more intermediate stations in the circuit, and to duplex an ordinary way circuit for all or only some of the offices on the line.

887,052. ELECTRICAL SYSTEM OF DISTRIBUTION; Walter E. Winship, New York, N. Y. App. filed Sept. 25, 1906. A system of distribution in which there is a motor generator connecting two sides of the system. Is directed to the regulation of the motor generator so that it may efficiently transfer energy from one side of the system to the other as the needs of the system require.